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PROGRAMA DE DOCTORADO EN RECURSOS Y TECNOLOGÍAS AGRARIAS, AGROAMBIENTALES Y ALIMENTARIAS

PRODUCTOS HIDROSOSTENIBLES: ACEPTACIÓN POR EL CONSUMIDOR

TESIS DOCTORAL

PAOLA SÁNCHEZ BRAVO

2021

Directora: Esther Sendra Nadal y **Codirector:** David B. López Lluch

Esta Tesis Doctoral, titulada "productos hidroSOStenibles: aceptación del consumidor", se presenta bajo la modalidad de **tesis por compendio** de las siguientes **publicaciones**:

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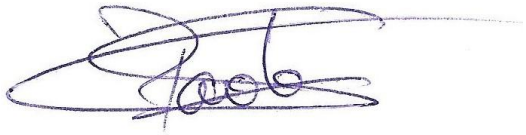
Esta memoria ha sido presentada por Dña. Paola Sánchez Bravo, Graduada en Ciencia y Tecnología de los Alimentos y Máster en Técnicas Avanzadas para la Investigación y Producción en Fruticultura, para la obtención del título de doctor.



Dña. Paola Sánchez Bravo

Esta Tesis Doctoral ha sido dirigida por la Dra. Esther Sendra Nadal, Catedrática de Universidad del Departamento Tecnología Agroalimentaria de la Universidad Miguel Hernández de Elche, y codirigida por el Dr. David B. López Lluch, Profesor Contratado Doctor del Departamento de Economía Agroambiental, Ingeniería Cartográfica y Expresión Gráfica en la Ingeniería de la Universidad Miguel Hernández de Elche, los cuales autorizan su presentación bajo la modalidad de tesis por compendio de publicaciones.

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CERTIFICA:

Que la Tesis Doctoral titulada "**Productos hidroSOStenibles: aceptación por el consumidor**", de la que es autora la Graduado en Ciencia y Tecnología de los Alimentos **Dña. Paola Sánchez Bravo**, ha sido realizada bajo la dirección de la **Dra. Esther Sendra Nadal** (UMH) y la codirección del **Dr. David B. López Lluch** (UMH), actuando como tutor de la misma el Dr. José Ramón Díaz Sánchez (UMH). Considero que la tesis es conforme en cuanto a forma y contenido a los requerimientos del Programa de Doctorado ReTos-AAA por tanto, es apta para su exposición y defensa pública.

Y para que conste a los efectos oportunos firmo el presente certificado en Orihuela a veintiséis de enero de dos mil veintiuno.

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ÍNDICE DE CALIDAD DE LAS PUBLICACIONES

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Autores

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Consumers attitude towards the sustainability of different food categories

Autores

Paola Sánchez-Bravo, Edgar Chambers V, Luis Noguera-Artiaga, David López, Edgar Chambers IV, Ángel A. Carbonell-Barrachina y Esther Sendra.

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Además de los indicios de calidad arriba reseñados, del trabajo desarrollado por la doctoranda dentro del marco de esta tesis doctoral, se han publicado los trabajos que a continuación se detallan:

Corell, M., Martín-Palomo, M. J., **Sánchez-Bravo, P**., Carrillo, T., Collado, J., Hernández-García, F., Girón, I., Andreu, L., Galindo, A., López-Moreno, Y. E., Centeno, A., Pérez-López, D., Carbonell-Barrachina, A. A., y Moriana, A (2019). Evaluation of growers' efforts to improve the sustainability of olive orchards: Development of the hydroSOStainable index. *Scientia Horticulturae*, 257, 108661.

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ÍNDICE

ESTRUCTURA DE LA TESIS DOCTORAL

El contenido de esta memoria se ha redactado de acuerdo con la normativa vigente de la Universidad Miguel Hernández de Elche para defender esta Tesis Doctoral bajo la modalidad de tesis por compendio de publicaciones. Por ello, esta memoria se ha estructurado de acuerdo con los siguientes puntos:

- **Resumen:** descripción de los resultados y conclusiones más relevantes (en castellano e inglés).
- **Introducción:** contextualización del estado del arte y la necesidad de desarrollar esta tesis.
- **Objetivos:** objetivo global y objetivos parciales de la investigación.
- **Resumen de la metodología:** breve descripción de la metodología empleada para la consecución de los objetivos.
- **Publicaciones científicas:** transcripción literal de las dos publicaciones científicas por las que se compone esta tesis: "*Consumer understanding of sustainability concept in agricultural products*" y "*Consumers' attitude towards the sustainability of different food categories*" publicados en las revistas *Food Quality and Preference* y *Foods*. Los artículos contienen información sobre el comportamiento y actitud de los consumidores de varias nacionalidades con respecto a los conceptos sostenible e hidroSOStenible.
- **Resumen de los resultados, discusión y conclusiones**: en el que se hace un breve resumen de los resultados obtenidos.
- **Conclusiones:** conclusiones de la Tesis Doctoral.
- **Investigaciones futuras**: breve descripción de futuras investigaciones que pueden desarrollarse a partir de los resultados obtenidos.
- **Anexos**: en ellos se incluyen aquellos resultados derivados de esta tesis doctoral y que quedan fuera del compendio de publicaciones anterior.
- **Referencias bibliográficas**: en las que se indican las referencias empleadas en las secciones complementarias a las publicaciones

RESUMEN

ABSTRACT

RESUMEN

La sostenibilidad se definió por primera vez en 1987 como la capacidad de satisfacer las necesidades de la generación actual sin comprometer la capacidad de las generaciones futuras para satisfacer sus propias necesidades. Este concepto se basa en 3 pilares fundamentales: medio ambiente, sociedad y economía. Actualmente, la pobreza, el cambio climático, la contaminación ambiental y el agotamiento de los recursos naturales han generado una mayor preocupación por la sostenibilidad. Para lograr el desarrollo sostenible, la agricultura es uno de los principales campos a considerar y es clave para abordar los problemas económicos, ambientales y éticos. El agua, especialmente en las regiones áridas y semiáridas, es cada vez más un bien disputado entre los diferentes sectores productivos, por lo que se prevé la necesidad de gestionar su uso de forma más sostenible en la agricultura. Se han realizado varios esfuerzos para mejorar la conservación de los recursos hídricos, pero la mayoría de ellos no han involucrado a los productores a nivel de campo; y, en consecuencia, han perdido la oportunidad de generar una mejora real en términos de sostenibilidad. Debido a la gran dificultad en la medición objetiva de todos los conceptos incluidos dentro de la sostenibilidad, establecer una única forma de abordarla resulta imposible. Actualmente, uno de los indicadores de sostenibilidad que se ha podido y puede objetivizarse para hacerlo medible es el esfuerzo por la optimización en el uso de agua en agricultura y en la transformación o elaboración de alimentos. Ya se dispone de índice de hidrosostenibilidad en campo para el cultivo del olivo y en la industria para la obtención de aceite de oliva virgen extra y aceituna de mesa. El índice de hidroSOStenibilidad evalúa 16 indicadores de campo agrupados en hidráulicos y agronómicos y, además, aquellos indicadores de calidad que muestran respuestas características o típicas en condiciones de riego deficitario controlado: (i) ácidos grasos, (ii) contenido de compuestos fenólicos y (iii) atributos sensoriales. Por otro lado, el último eslabón, el consumo sostenible, depende de las percepciones de sostenibilidad de los consumidores y de cómo afectan a su comportamiento. Cada vez más los consumidores demandan alimentos producidos bajo prácticas sostenibles y buscan involucrarse en el proceso de mejora de la sostenibilidad alimentaria. Bajo tales premisas, el objetivo de tesis doctoral fue identificar los segmentos de consumidores en función de su percepción y aceptación de sostenibilidad e hidrosostenibilidad. Para comprender cómo los consumidores perciben la sostenibilidad y las opciones para ahorrar agua en la cadena alimentaria se realizó un estudio de consumidores *on-line* en Brasil, China, India, México, España y Estados Unidos, con 600 consumidores por país. Se evaluó el efecto de los factores país, edad, género, ingresos y nivel educativo. A los participantes se les hicieron preguntas organizadas en diferentes niveles: sostenibilidad general y disposición a pagar en

diferentes categorías de alimentos, sostenibilidad en las categorías de alimentos, hidroSOStenibilidad en las categorías de alimentos y el empleo de un logotipo hidroSOStenible.

Los consumidores tienen una idea confusa de lo que es un producto sostenible, relacionándolo sobre todo con alimentos ecológicos y de mayor calidad. Los países menos desarrollados, como la India, mostraron una mayor disponibilidad a pagar un precio más alto por este tipo de productos, e independientemente del país, los consumidores piensan que las categorías de alimentos en las que es posible ahorrar más agua son las vinculadas directamente a los productos agrícolas, es decir, "cereales y productos a base de cereales" y "hortalizas, frutos secos y legumbres". Además, los consumidores no asocian los productos procesados, como los *snacks*, con un alto consumo de agua, a pesar de que provienen de productos agrícolas como los cereales y requieren más procesamiento. En general, se encontró que la actitud de los consumidores hacia la sostenibilidad se entiende de manera diferente en cada país. Los consumidores con menor nivel educativo y las generaciones mayores mostraron el menor conocimiento y preocupación por la sostenibilidad alimentaria y los problemas relacionados. El nivel de ingresos afectó en a la percepción dependiendo del grupo de alimentos y el género no modificó la percepción.

Los resultados suponen un incuestionable progreso en el campo de la fruticultura y proporcionan un valor añadido a los frutos (índice de hidroSOStenibilidad) que permitirá su adaptación a las nuevas tendencias del mercado. A su vez, permitirá desarrollar estrategias para sensibilizar a la población y segmentar las campañas de formación según el colectivo al que van dirigidas proporcionará una mayor concienciación y un mayor impacto para alcanzar un futuro sostenible.

ABSTRACT

Sustainability was first defined in 1987 as the ability to meet the needs of the current generation without compromising the ability of future generations to meet their own needs. This concept is based on 3 fundamental pillars: environment, society and economy. Currently, poverty, climate change, environmental pollution and the depletion of natural resources have generated greater concern about sustainability. To achieve sustainable development, agriculture is one of the main fields to consider and it is key to addressing economic, environmental and ethical problems. Water, especially in arid and semi-arid regions, is increasingly a disputed commodity among the different productive sectors, so the pressure for a more sustainable use of water in agriculture will increase. Various efforts have been made to improve the conservation of water resources, but most of them have not involved farmers at the orchard level; and consequently they have missed the opportunity to generate a real improvement in terms of sustainability. Due to the difficulty in the objective measurement of all the concepts included within sustainability, establishing a single way of approaching it is impossible. Currently, one of the sustainability indicators that has been and can be objectified to make it measurable is the effort to optimize the use of water in agriculture and in food processing or processing. A hydroSOStainability index is already available in the field for olive cultivation and in the industry to obtain extra virgin olive oil and table olives. The hydroSOStainability index evaluated 16 field indicators grouped into hydraulic and agronomic and, in addition, those quality indicators that show characteristic or typical responses under regulated deficit irrigation conditions: (i) fatty acids, (ii) content of phenolic compounds and (iii) sensory attributes. On the other hand, sustainable consumption depends on consumers' perceptions of sustainability and how they affect their behavior. More and more consumers demand food produced under sustainable practices and seek to get involved in the process of improving food sustainability. Under these premises, the objective of this doctoral thesis was to identify consumer segments based on their perception and acceptance of sustainability and hydroSOStainability. An online study was carried out in Brazil, China, India, Mexico, Spain and the United States, with 600 consumers per country, to understand how consumers perceive sustainability and the options to save water in the food chain. Results were analyzed by country, age, gender, income and educational level. Participants were asked questions organized at different levels: general sustainability and willingness to pay in different food categories, sustainability in food categories, hydroSOStainability in food categories and the use of a hydroSOStainable logo.

Consumers have the wrong idea of what a sustainable product is, relating it above all to organic and high quality food. Less developed countries, such as India, showed a greater willingness to pay a higher price for these types of products, and regardless of the country, consumers think that the food categories in which it is possible to save more water are those directly linked to agricultural products, that is, “cereals and cereal-based products” and “vegetables, nuts and legumes”. In addition, consumers do not associate processed products, such as snacks, with a high consumption of water, despite the fact that they come from agricultural products such as cereals and require more processing. In general, it was found that the attitude of consumers towards sustainability is understood differently in each country. Consumers with less education and the older generations showed the least knowledge and concern about food sustainability and its related problems. Perceptions as a function of the level of income varied depending on the food group and gender did not affect.

The results represent unquestionable progress in the field of fruit sustainability and provide added value to the fruits that will allow them to adapt to new market trends. Together, sensitizing the population and segmenting training campaigns according to the group they are aimed at will provide greater awareness and greater impact to achieve a sustainable future.

INTRODUCCIÓN

1

El concepto de sostenibilidad se ha utilizado desde la segunda mitad del siglo XX. Inicialmente, estaba relacionado con los recursos naturales, pero en los últimos años se ha asociado con una amplia gama de actividades económicas. Hoy en día, la palabra "sostenibilidad" o “sostenible” es probablemente uno de los términos más comunes en la publicidad de diferentes productos. Producir de forma sostenible es cada vez más importante debido a los problemas mundiales actuales: pobreza, cambio climático, contaminación ambiental y finitud de los recursos naturales (Buerke *et al.*, 2017).

La sostenibilidad surge como un concepto en 1987 y fue definida por la Organización de las Naciones Unidas (ONU) como la capacidad de "satisfacer las necesidades de las generaciones actuales sin comprometer la capacidad de las generaciones futuras para satisfacer sus propias necesidades" (Kuhlman y Farrington, 2010; ONU, 1987). Desde entonces, muchas formas de definir la sostenibilidad han entrado en escena. Brown *et al.* (1987) señalaron algunas características comunes que están involucradas en el concepto de sostenibilidad: (i) El apoyo continuo de la vida humana en la tierra; (ii) el mantenimiento a largo plazo del stock de recursos biológicos y la productividad de los sistemas agrícolas; (iii) poblaciones humanas estables; (iv) economías de crecimiento limitado; (v) énfasis en la pequeña escala y la autosuficiencia; y (vi) calidad continua en el medio ambiente y los ecosistemas. Por otro lado, Moore *et al.* (2017) propusieron un resumen de la definición de sostenibilidad a través de constructos. Estos fueron: (i) después de un período de tiempo definido; (ii) continúan entregando un programa, intervención específica y/o estrategias de implementación y/o (iii) se mantiene el cambio de comportamiento individual; (iv) el programa y el cambio de comportamiento individual pueden evolucionar o adaptarse; y (v) han de continuar produciendo beneficios para individuos/sistemas.

El aspecto clave de la definición de sostenibilidad es su perspectiva antropocéntrica. El objetivo real es la supervivencia de la especie humana en todas las regiones del mundo y la persistencia de todos los componentes de la biosfera, incluso aquellos que aparentemente no benefician a la humanidad (Brown *et al.*, 1987). Sin embargo, todo esto depende del comportamiento humano y supone, al menos, tres ámbitos centrales de la sostenibilidad (Phipps *et al.*, 2013): (i) ambiental (protección del medio ambiente y recursos naturales), (ii) sistemas sociales y culturales y (iii) económico (promoción de las condiciones de vida de los seres humanos). Estos factores se refuerzan mutuamente y pueden lograrse mediante la gestión del capital físico, natural y humano (Naciones Unidas, 2012). Siguiendo la propuesta de Phipps *et al.*, (2013), en 2015, los Estados Miembros de las Naciones Unidas aprobaron un plan de desarrollo sostenible para los próximos 15 años (2030), destinado a la erradicación de la

pobreza, cambio climático y el desarrollo sostenible en sus tres dimensiones (social, económica y ambiental) con el objetivo final de alcanzar un futuro sostenible (Naciones Unidas, 2015). Dicho plan, consta de 17 objetivos (**Figura 1**), entre los cuales se encuentra el objetivo 6 (meta 6.4) que consiste en aumentar considerablemente el uso eficiente de los recursos hídricos en todos los sectores y asegurar la sostenibilidad de la extracción y el abastecimiento de agua dulce para hacer frente a la escasez de agua (Naciones Unidas, 2020).

Figura 1. Objetivos de Desarrollo Sostenible para la Agenda 2030 de las Naciones Unidas.

Dentro de este ámbito encontramos también la estrategia de la Comisión Europea titulada "De la granja a la mesa", que contribuye a desarrollar un sistema alimentario sostenible desde la producción hasta el consumo (**Figura 2**). Esta estrategia tiene como objetivo acelerar nuestra transición a un sistema alimentario sostenible que debería tener un impacto ambiental neutro o positivo, ayudar a mitigar el cambio climático y adaptarse a sus impactos, revertir la pérdida de biodiversidad, garantizar la seguridad alimentaria, la nutrición y la salud pública, asegurándose de que todos tengan acceso a alimentos suficientes, inocuos, nutritivos y sostenibles y preservar la asequibilidad de los alimentos al tiempo que se generan beneficios económicos más justos, se fomenta la competitividad del sector de suministro de la UE y se promueve el comercio justo (Comisión Europea, 2020).

Figura 2. Estrategia "De la granja a la mesa" (Comisión Europea, 2020).

1.1. *Sostenibilidad Ambiental*

Para lograr el desarrollo sostenible, la agricultura es uno de los principales campos a considerar y es esencial para abordar los problemas económicos, ambientales y éticos en todo el mundo (Meyer-Höfer, 2014). En la agricultura, el significado comúnmente aceptado de sostenibilidad es el de conservar la cantidad de recursos naturales a largo plazo para mantener un cierto nivel de producción indefinidamente (Villalobos y Fereres, 2016). Aunque más recientemente, la definición de agricultura sostenible ha incluido estilos de gestión que son viables desde un punto de vista económico y aceptable desde un punto de vista social (Villalobos y Fereres, 2016).

Uno de los principales aspectos de la sostenibilidad ambiental es el ahorro de agua. El riego sostenible no está claramente definido. Gleick *et al.* (1995) consideraron que el riego sostenible implica un uso del agua de modo que el ciclo hidrológico y los sistemas ecológicos no estén siendo dañados. Una definición más precisa incluiría conceptos como la cantidad y la calidad de los recursos hídricos a largo plazo (Khan *et al.*, 2004; Wichelns y Oster, 2006) y la productividad del agua (la productividad del agua se puede estimar como la relación entre el rendimiento y el agua aplicada; kg m^{-3}) (Khan *et al.*, 2004). De acuerdo con Khan *et al.* (2004), el objetivo de mejorar la sostenibilidad del riego en un área agrícola podría estar asociado con el aumento de la productividad del agua. Tal aumento en la productividad del agua ha sido comúnmente respaldado con políticas públicas centradas en mejorar el drenaje del agua o la conducción del agua antes del nivel de la parcela/finca. Sin embargo, estas grandes inversiones no han conseguido involucrar hasta el momento a los productores y el ahorro de agua antes de la finca

ha sido menor que el desperdicio de agua a nivel de parcela (Wichelns y Oster, 2006). De hecho, el nivel de parcela es la parte más importante en la definición de la productividad del agua en una cuenca hidrológica porque los cultivos (Azad *et al.*, 2015) y el manejo del agua de los productores (Herath *et al.*, 2013) son las principales fuentes de variación.

Con respecto al agua y la energía, se estima que la agricultura utiliza aproximadamente el 70 % del agua dulce mundial (**Figura 3**) y el sector alimentario consume aproximadamente el 30 % de la energía en todo el mundo (FAO, 2011; Jeswani *et al.*, 2015). En la mayoría de los agrosistemas mundiales, no es posible obtener el máximo rendimiento de los cultivos sin un suministro adecuado de agua de riego para complementar el aporte de agua de lluvia y evitar el estrés hídrico de las plantas. De esta forma, se obtiene un rendimiento de fruta regular y se evita, o al menos se reduce, un patrón de producción alternativo. Sin embargo, en general, este tipo de agricultura plantea serios riesgos para la naturaleza porque, entre otros problemas, causa pérdida de biodiversidad, tiene un consumo extremadamente alto de agua dulce, contribuye al cambio climático a través de las emisiones de gases de efecto invernadero e interfiere en gran medida con el ciclo del nitrógeno y el fosfato (N y P) (Willett *et al.*, 2019). El uso abusivo de fertilizantes de N y P ha acelerado los procesos de eutrofización, mientras que el uso excesivo del agua de riego ha agotado los acuíferos y reducido los caudales de los ríos en ciertas regiones, especialmente en aquellos con agricultura intensiva en regiones áridas o semiáridas (Darré *et al.*, 2019; McLaughlin y Kinzelbach, 2015).

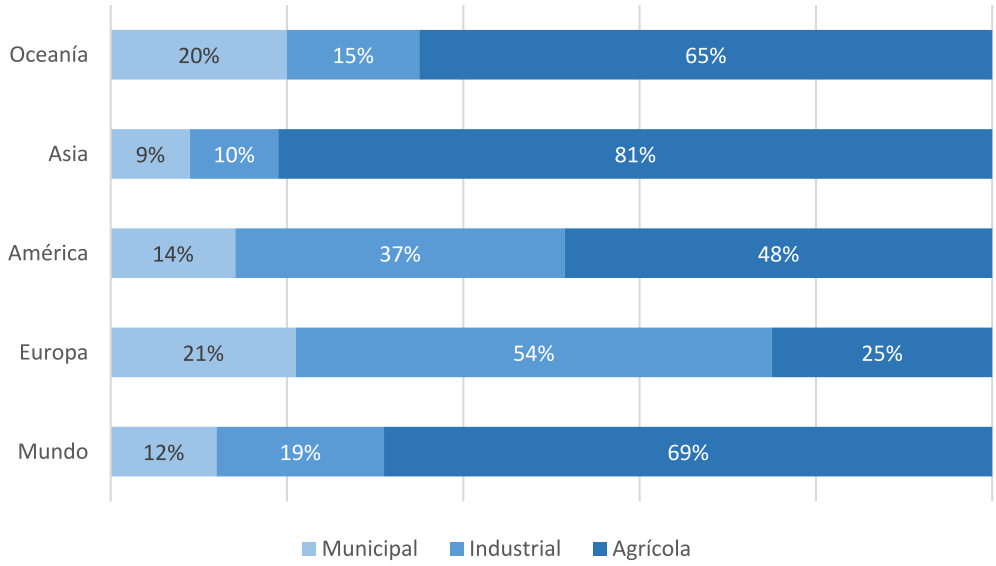

Figura 3. Consumo de agua dulce por sectores (AQUASTAT, 2016).

Por otro lado, a medida que aumenta la población, el agua, especialmente en las regiones áridas y semiáridas, es cada vez más un producto en disputa entre los diferentes sectores productivos. Esta competencia por el agua se debe a la expansión de actividades urbanas, turísticas e industriales que con frecuencia generan tensiones, conflictos entre usuarios y presiones extremas sobre el medio ambiente (Rodríguez *et al.*, 2018). Está claro que el cambio climático conducirá inevitablemente a sequías muy frecuentes y severas en un futuro cercano (Collins, 2009). Por lo tanto, la presión para un uso más sostenible del agua en la agricultura crecerá y, en consecuencia, los agrosistemas áridos y semiáridos se verán obligados a hacer frente a la escasez de agua y a practicar una agricultura sostenible. En este sentido, las principales estrategias para hacer frente a la escasez de agua son (i) el uso de prácticas mejoradas, innovadoras y precisas de gestión del riego por déficit que puedan minimizar el impacto en el rendimiento y la calidad de la fruta, y (ii) el uso de materiales vegetales con baja demanda de agua y/o capaz de soportar el riego deficitario con un impacto mínimo en el rendimiento y la calidad de la fruta (Galindo *et al.*, 2018).

Galindo *et al.* (2018) indicó que en los agrosistemas mediterráneos, para ahorrar agua y proteger la integridad de los recursos hídricos, es necesario diversificar los hábitos de producción y consumo. Estos hábitos incluyen el uso de una gama más amplia de especies de plantas, como las que actualmente se están subutilizando y que necesitan un bajo aporte de fertilizantes sintéticos, pesticidas y agua. Además, estos autores indicaron que este nuevo enfoque debe ser compatible con la consolidación del cultivo de cultivos tradicionales, como las aceitunas, las almendras o las vides, que son cultivos de baja demanda de agua.

El riego deficitario puede mejorar la calidad de la fruta al elevar el porcentaje de materia seca y los niveles de compuestos bioactivos saludables (Collado-González *et al.*, 2014; Collado-González *et al.*, 2015). Entre estos compuestos, debe hacerse una mención particular a una gran variedad de metabolitos secundarios, principalmente compuestos fenólicos. Estos compuestos representan una fuente importante de actividades biológicas (Bourgaud *et al.*, 2001) y con frecuencia se han asociado con efectos beneficiosos para la salud humana (Hooper y Cassidy, 2006). El riego deficitario controlado (RDC) es probablemente la estrategia de riego deficitario más útil para mejorar el ahorro de agua y, si se aplica adecuadamente, para aumentar la calidad de la cosecha sin o teniendo un impacto mínimo en el rendimiento comercializable. El RDC se basa en reducir el riego, o incluso detener por completo el riego, durante los períodos fenológicos tolerantes al estrés hídrico (períodos no críticos) y proporcionar riego completo durante los períodos fenológicos sensibles al estrés hídrico (períodos críticos) (Chalmers *et al.*, 1981; Galindo *et al.*, 2018; Geerts y Raes, 2009), mientras que el riego completo proporciona

condiciones de agua no limitantes (100 % de la evapotranspiración, ET_c) al cultivo durante todo el ciclo de la planta.

Sin embargo, el riego deficitario, incluso para estas especies, no está definitivamente vinculado a un manejo sostenible. La reducción en el uso de agua podría convertirse en ganancias económicas pobres (incluso nulas) o una respuesta de rendimiento poco clara (Moriana *et al.*, 2007). La gestión adecuada del agua a nivel de parcela significa un aumento de los costos, pero no necesariamente de las ganancias. En estas condiciones, los productores no apoyarán un enfoque de riego sostenible a nivel de finca. Noguera-Artiaga *et al.* (2016) sugirieron la definición de "productos hidroSOStenibles" como frutas y verduras cultivadas bajo RDC. Estos autores informaron que los consumidores españoles estaban dispuestos a pagar una cantidad adicional de 1.0 € kg^{-1} por pistacho con ese nombre comercial (Noguera-Artiaga *et al.*, 2016). La implicación es que, si se puede obtener un aumento de precios, los cambios en la gestión del agua se promoverán fácilmente. Por tanto, la pregunta se convierte en cómo se podría evaluar este esfuerzo económico de mejora de la sostenibilidad del riego a nivel de parcela.

Existen algunos enfoques para evaluar la gestión del agua a nivel de parcela. La viticultura sostenible en Nueva Zelanda presentó un protocolo en el que el tema del riego solo consideraba unas pocas opciones de gestión (programación del riego, productividad del agua y cantidad de agua aplicada) (SWNZ, 2017). La huella hídrica es un enfoque que considera todo el proceso de producción hasta que el producto llega al consumidor final, es decir, a lo largo de toda la cadena de suministro. La huella hídrica se divide en tres niveles: azul, verde y gris (**Figura 4**). El azul se refiere al consumo de agua superficial y subterránea; el verde implica el consumo de agua de lluvia; y el gris define el volumen de agua dulce que se necesita para asimilar la contaminación causada (Hoekstra *et al.*, 2011). Aunque el consumo de agua a nivel de campo es el componente más variable en el ciclo, este enfoque solo considera la cantidad y el tipo de agua utilizada, y no el esfuerzo real de los productores para mejorar su gestión en sus condiciones ambientales y de disponibilidad de agua particulares. Una parcela que recibe una gran cantidad de lluvia y con pocas necesidades de agua podría tener una huella hídrica baja, incluso si el manejo del agua fuera muy ineficiente, como ocurre en algunos viñedos en Nueva Zelanda (Herath *et al.*, 2013). Sin embargo, abordar la eficiencia del agua en las cadenas de suministro, especialmente de los productos básicos, puede fomentar el consumo de productos sostenibles e impulsar soluciones sostenibles en la gestión del agua (Vanham y Bidoglio, 2013). Investigaciones anteriores sugieren que cuando los consumidores comprenden los antecedentes del uso del agua, es más probable que sean más conscientes de la huella hídrica y conserven el agua (Gómez-Llanos *et al.*, 2020).

Figura 4. Indicadores de la huella hídrica (Vanham y Bidoglio, 2013).

1.2. *Sostenibilidad Social y Cultural*

La sociedad y la cultura son otros agentes clave para el desarrollo sostenible, siendo la salud humana su núcleo. El aumento de los rendimientos de los cultivos al intensificar las prácticas agrícolas (por ejemplo, el cultivo de olivos de súper alta densidad) ha contribuido positivamente a la esperanza de vida y la reducción del hambre (Steffen *et al.*, 2015; Whitmee *et al.*, 2015; Willett *et al.*, 2019). Sin embargo, la mejora de la disponibilidad de alimentos y los cambios sociales hacia alimentos listos para el consumo y comida rápida han llevado a dietas poco saludables (dietas altas en calorías, con alto consumo de productos animales), contribuyendo a la degradación del medio ambiente (Springmann *et al.*, 2016; Tilman y Clark, 2014; Willett *et al.*, 2019). Estos hábitos se han visto favorecidos por los cambios de la sociedad, como la urbanización y la incorporación de la mujer al trabajo. Los salarios urbanos más bajos tienden a una alta ingesta de productos poco saludables, como comida rápida y / o alimentos listos para el consumo, que tienden a aumentar la ingesta de sal, grasa y azúcar de los consumidores (Cohen y Garrett, 2010). Para cambiar esta situación, surge el concepto de "dieta sostenible", considerando no solo la salud humana (nutrición) y el medio ambiente, sino también aspectos culturales, sociales y económicos (FAO, 2010; Green *et al.*, 2018). En 2018, el porcentaje de consumidores que consideraron la sostenibilidad en los alimentos que comieron como un factor importante aumentó en comparación con años anteriores (IFIC, 2018). Por estas razones, ser capaz de comprender lo que los consumidores entienden por alimentos sostenibles y sostenibilidad es esencial para promover cambios de dieta hacia dietas saludables y sostenibles. Para alcanzar el objetivo de disponer de alimentos sostenibles, evitando prácticas fraudulentas o amenazas para la salud y el medio ambiente, los sistemas de certificación pueden desempeñar un papel clave (Meyer-Höfer, 2014), así como la educación al consumidor mediante campañas de formación.

1.3. *Sostenibilidad Económica*

La economía debe ser parte de la sostenibilidad. Para ello, se deben tener en cuenta la sociedad, el medio ambiente, las perspectivas de futuro, la eficiencia económica y la justicia entre generaciones y entre los humanos y la naturaleza (Baumgärtner y Quaas, 2010). La economía depende en gran medida de la naturaleza y, por lo tanto, la actividad económica debe estar limitada por la capacidad finita de la biosfera para regenerar recursos y asimilar desechos.

El concepto de sostenibilidad, muy ligado a la agricultura y medio ambiente, es empleado de forma generalizada en toda actividad económica. En muchos casos el concepto de sostenibilidad se ha empleado como un reclamo publicitario para conseguir más clientes, vaciando de contenido la idea y ofreciendo productos que realmente no consideran un manejo social y medio ambiental adecuados. Por ejemplo, los productos financieros sostenibles que se incluyeron hace unos años dentro del *Dow Jones Sustainability Index (DJSI)*. Las características más importantes para ser aceptado dentro de este índice eran de carácter puramente económico, con poca importancia de los valores sociales o ecológicos de la inversión de la empresa (Fowler y Hope, 2007). Sin embargo, aunque actualmente este índice también incluye, además del aspecto económico, aspectos ambientales y sociales (**Figura 5**), este tipo de estrategias comerciales da lugar a una banalización del concepto de sostenibilidad, lo que a largo plazo puede suponer una falta de interés de la sociedad por manejos que realmente sean respetuosos con el medio natural.

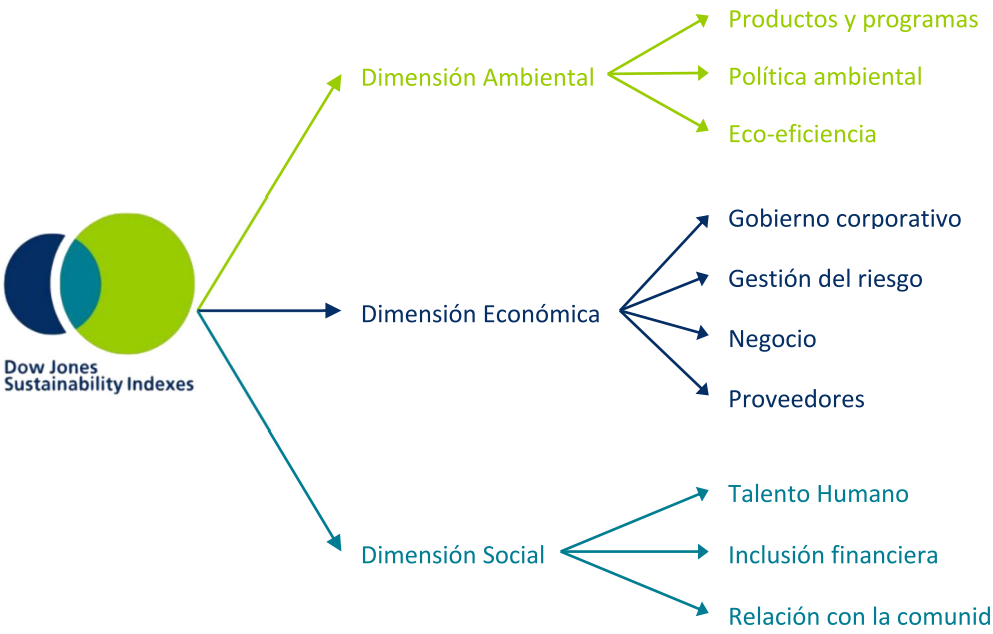

Figura 5. Criterios evaluados por *Dow Jones Sustainability Index* (*DJSI*) en cada una de sus dimensiones (S&P Dow Jones Indices, 2020).

1.4. *Índice de hidroSOStenibilidad*

En la actualidad, es posible determinar el nivel de ahorro de agua de un cultivo o producto de manera objetiva. Este sistema se denomina índice de hidroSOStenibilidad y se encuentra establecido para el cultivo del olivo y sus productos derivados (aceite de oliva virgen extra y aceitunas de mesa procesadas). Este índice se desarrolló tras realizar un estudio completo de los diferentes indicadores que permiten aplicar riego deficitario controlado (RDC) y mejorar el ahorro de agua en olivos. En él, se identificaron aquellas medidas que pueden caracterizar un producto procedente de un manejo eficiente del agua en la parcela y que den lugar a una mejora de las características del producto final, en este caso de la aceituna de mesa y del aceite de oliva virgen extra. El propósito final del mismo fue proporcionar a los agricultores una forma de acreditar y poner en valor las prácticas agronómicas llevadas a cabo de forma sostenible, y permitir a los consumidores, en un futuro, tener toda la información posible para que puedan basar su decisión de compra en aspectos sostenibles y/o en base a las propiedades funcionales y organolépticas del producto.

El concepto "hidroSOStenible" fue desarrollado por grupos interdisciplinares de investigación y registrado por el grupo Calidad y Seguridad Alimentaria (CSA) de la Universidad Miguel Hernández de Elche, junto con la empresa GALVEZ PRODUCTOS AGROQUÍMICOS S.L. (GALPAGRO). Este concepto está registrado en la Oficina de Propiedad Intelectual de la Unión Europea y en la Oficina Española de Patentes y Marcas (Referencias: 017411083 y M3647842, respectivamente).

En los últimos años, el grupo de investigación de Calidad y Seguridad Alimentaria de la UMH, y sus colaboradores (Universidad de Sevilla, Centro de Edafología y Biología aplicada del Segura (CEBAS-CSIC), Universidad Politécnica de Madrid e Instituto de Investigación y Formación Agraria y Pesquera (IFAPA)), a través de los proyectos **AGL2013-45922-C2-1-R (e-SOS-agua),** titulado "*evaluación de la calidad y funcionalidad de productos hidroSOStenibles y aceptación en el mercado nacional e internacional*" y **AGL2016-75794-C4-1-R (HidroSOS mark),** titulado "p*roductos hidroSOStenibles: identificación de debilidades y fortalezas, optimización del procesado, creación de marca propia y estudio de su aceptación en el mercado europeo*", han estudiado el efecto del riego deficitario controlado (RDC) y sus efectos en diversos cultivos (pistachos, almendras, granada, aceite de oliva virgen extra y aceitunas), demostrando tener efectos beneficiosos sobre la acumulación de compuestos bioactivos en los frutos, y también en la satisfacción del consumidor (Cano-Lamadrid *et al.*, 2015; Carbonell-Barrachina *et al.*, 2015;

Galindo *et al.*, 2017; Lipan *et al.*, 2020; Lipan *et al.*, 2019; Noguera-Artiaga *et al.*, 2020; Noguera-Artiaga *et al.*, 2016; Sánchez-Rodríguez *et al.*, 2019).

Para desarrollar estos índices se obtuvieron datos de tres parcelas de olivar, una comercial y dos experimentales. La finca "el Morillo" (comercial), localizada en Carmona (37,49 °N, -5,67 °W, Sevilla, España,) fue empleada para los estudios de aceite. Llevaron a cabo un diseño experimental de 4 bloques al azar con 4 tratamientos de riego (control, RDC óptimo, RDC con limitación de confederación y riego deficitario sostenido (RDS) con limitación de confederación) durante tres campañas (2017-2018-2019). El cultivo tuvo una densidad superintensiva (4,0 m × 1.5 m), 360 m^2, y cuenta con 60 árboles en seto de la variedad cv. Arbequina organizados en líneas de 30 m. Para la aceituna de mesa emplearon las fincas experimentales "Doña Ana", ubicada en Dos Hermanas (37,25 °N, 5,95 °W, Sevilla, España) y "La Hampa", localizada en Coria del Río (37,17 °N, 6,3 °W, Sevilla, España). En la primera de ellas utilizaron un diseño experimental de 4 bloques a azar con 4 tratamientos de riego (control, RDC óptimo o estrés moderado, RDC puntual con recuperación rápida y RDC severo) durante tres temporadas (2015-2016-2017) y en la segunda emplearon un diseño experimental de 3 bloques al azar con 3 tratamientos de riego (RDC óptimo, RDC moderado y RDC severo) durante tres temporadas (2014-2015-2016). En ambas fincas se empleó la variedad cv. Manzanilla de Sevilla. Durante el período experimental, todas las fincas tuvieron un clima mediterráneo, con inviernos cálidos y veranos calurosos y secos.

La mayoría de los investigadores que participaron en el desarrollo de los índices llevan trabajando juntos desde los últimos 10 años en la programación del riego deficitario de olivos y almendros, entre otros cultivos. Por este motivo, los indicadores seleccionados para este estudio fueron aquellos consensuados por los expertos investigadores de los proyectos mencionados anteriormente y mediante bibliografía consultada.

La evaluación de un proceso productivo en una parcela es muy compleja debido al gran número de factores que podrían afectar los resultados finales. No sólo es difícil su descripción, también la cuantificación de la importancia de cada factor en la sostenibilidad del uso del agua. Es probable que con el paso del tiempo algunos procesos cambien en cuanto a su peso relativo en el manejo del agua o incluso a largo plazo ni siquiera deban considerarse. Asimismo, la calidad y propiedades organolépticas del fruto o sus derivados está influenciada por la implementación de buenas prácticas agronómicas. Es muy complicado definir el concepto de calidad en frutas porque involucra muchos aspectos diferentes (características físicas y químicas, atributos sensoriales, efectos saludables, aspectos tecnológicos y económicos, etc.). Además de esta

complejidad, es necesario mencionar que los indicadores de calidad cambian con el tiempo y pueden ser diferentes en diferentes países y mercados (Urbina-Vallejo, 1990). Estas son algunas de las razones por las que los protocolos utilizados en esta área deben revisarse periódicamente para incorporar o cuantificar elementos nuevos o dependientes del tiempo.

Corell *et al.,* 2019 y Sánchez-Bravo *et al.,* 2020 denominan como "índice de riego hidroSOS" a aquel que identifica, describe y evalúa diferentes indicadores de mejora de la sostenibilidad del riego en la parcela, e "índice de calidad hidroSOS" al que establece aspectos tecnológicos, características físicas y químicas y atributos sensoriales, considerados dentro de la calidad del producto. Ambos índices hidroSOS (riego y calidad) son complementarios y han sido definidos siguiendo una estructura similar a la del "*Seattle Green Factor*" (Seattle Department of Construction and Inspections, 2019), que fue diseñado para evaluar zonas urbanas verdes. Puesto que cada fruta tiene unas características diferenciadas y unos requerimientos de agua específicos, el índice hidroSOS debe determinarse de forma independiente para cada cultivo. En este caso, el índice se centra en el olivo y en sus productos derivados: aceite de oliva virgen extra y aceitunas procesadas.

1.4.1. Índice de riego HidroSOS.

El concepto clave en el índice de riego hidroSOS es la programación de riego basada en RDC. Esta estrategia permite reducir, e incluso suprimir, el riego durante las fases fenológicas no críticas al déficit hídrico (Chalmers *et al.,* 1981; Goldhamer, 1999; Galindo *et al.,* 2018; Geerts y Raes, 2009). Esta estrategia de riego ha sido empleada en distintos cultivos, manteniendo la producción y, a veces, mejorando la calidad de los frutos (Fernandes-Silva *et al.*, 2013; Lipan *et al.*, 2019; Moriana *et al.*, 2003; Noguera-Artiaga et al., 2020; Noguera-Artiaga et al., 2019). Según los trabajos de RDC del olivo, el endurecimiento del hueso es la etapa fenológica resistente a la sequía (Fernández *et al.*, 2013; Girón *et al.*, 2015; Goldhamer, 1999; Iniesta *et al.*, 2009; Moriana *et al.*, 2003)

El índice de riego hidroSOS incluye diferentes indicadores que permiten ahorrar agua aplicando RDC. Estos indicadores se traducen en una puntuación cuya suma proporcionará el valor global que nos indicará el grado de hidroSOStenibilidad de la parcela o índice hidroSOS. Los indicadores se agrupan en hidráulicos y agronómicos:

- Indicadores hidráulicos

Los indicadores hidráulicos, relacionados con el diseño del riego. Incluyen:

  - Tipo de riego: En el caso del olivar, cultivo leñoso, y considerando que se busca el mayor ahorro de agua, el riego por goteo y la microaspersión se consideran los más adecuados, ya que aseguran un mejor control del agua aplicada. Por lo tanto, solo a estos dos tipos de riego les asignan una calificación superior. Si en la parcela se encontraran varios tipos, se puntuarán los instalados en una superficie mayor.

  - Número y caudal de emisores (goteros/microaspersores): La cantidad de emisores de riego en la parcela es muy importante para la eficiencia del riego. Un bajo número de goteros por árbol aumentaría el tiempo de riego e incluso podría dificultar la aplicación de dosis adecuadas durante el período de recuperación. Para evaluar estos indicadores, consideran un mínimo de superficie de suelo húmedo de alrededor del 35-40 % de superficie de la copa (Gispert-Folch, 2003). De acuerdo con la evapotranspiración diaria del cultivo del olivo (entre 4-5 mm día^{-1}), un sistema hidráulico que proporcione alrededor de 1 mm h^{-1} (entre 0,8 a 1,2 mm h^{-1}) sería aceptable. Para este indicador no se consideran otros tipos de riego diferente a goteo o microaspersión.

  - Frecuencia de riego: Solo se considera un sistema de alta frecuencia (1-3 días).

  - Uniformidad de distribución del agua en la parcela: El diseño y el mantenimiento del sistema de riego están relacionados con la uniformidad de distribución. Una gran heterogeneidad en la forma en que se aplica el agua en una parcela significa que algunas áreas podrían estar sobrerregadas, mientras otras recibirían una cantidad menor de agua. Según el tipo de riego considerado (goteo o microaspersión), el enfoque considera como adecuados sólo valores superiores al 95 % o entre 90-95 %.

- Indicadores agronómicos

Estos indicadores incluyen todos los tipos de gestión hortícola relacionados con la gestión del agua a nivel de parcela. Este grupo es el más importante en el enfoque del índice hidroSOS y es el que los agricultores pueden variar de forma más sencilla. Estos indicadores se agrupan en tres: indicadores no directamente relacionados con la programación del riego, indicadores del momento en que ocurre el estrés hídrico e indicadores del nivel de estrés hídrico.

- Indicadores no directamente relacionados con la programación del riego
    - Procedencia del agua de riego. El riego con agua reutilizada o agua desalinizada podría mejorar el presupuesto hidrológico a nivel de cuenca porque se consumiría menos agua de otros orígenes. El uso de una estructura para almacenar el agua de lluvia, y su uso en el riego de la parcela, también mejora la sostenibilidad del sistema. Este indicador considera 4 niveles basados en la superficie regada de la parcela que solo usa agua reutilizada o desalada (100, 100-75, 75-50 y 50-25 %).

    - Manejo del suelo. El manejo del suelo podría reducir la evaporación y la escorrentía mejorando así el balance hidrológico. Cubrir el suelo con cultivos o malezas durante el período de lluvia reduce la escorrentía en los olivares (Pastor *et al.*, 2001). Los sistemas de no laboreo aumentan la infiltración y reducen la evaporación del suelo (Pastor, 1989). Por lo tanto, las cubiertas vegetales obtendrán la puntuación máxima y las parcelas sin laboreo se considerarán positivas.

    - Calidad del agua de riego. La calidad del agua puede afectar a la sostenibilidad de dos formas. Primero, cuando no disminuye con el uso agrícola se considera riego sostenible (Khan *et al.*, 2004; Wichelns y Oster, 2006). Por otro lado, un agua de baja calidad significa un aumento de la lixiviación y, en consecuencia, un aumento del consumo de agua. El enfoque hidroSOS puntúa positivamente el análisis anual de salinidad en el agua de riego y, además, el análisis de los requisitos de lixiviación (LR). Cuando el exceso de lluvia estacional sea menor que LR, el riego debe incluir agua adicional para mantener la salinidad del suelo dentro de valores adecuados. Por tanto, estos requisitos adicionales no deben penalizar la evaluación y se descontarán del agua estacional aplicada para calcular el índice.

    - Eficiencia en el uso del agua. La productividad o eficiencia del uso del agua se puede estimar como la relación entre el rendimiento y el agua aplicada. El índice HidroSOS considerará en olivo: valores superiores a 6 kg m^{-3} (máxima puntuación) y valores entre 3 y 6 kg m^{-3} (puntación media). En general, no se considerarán valores inferiores a 3 kg m^{-3}. Sin embargo, ~~se~~ han reportado rendimientos casi nulos en los olivares (Moriana *et al.*, 2013) y tales valores no están necesariamente asociados a un manejo del riego inadecuado.

Para incluir esta posibilidad, Lorite *et al.* (2012) sugirieron el uso del concepto de suministro de riego relativo anual (ARIS):

$$ARIS = \frac{Riego}{(ETc - P)}$$

Dónde,

ARIS: suministro de riego relativo anual.

Riego: cantidad estacional de riego.

ET_c: evapotranspiración durante el período de riego.

P: pluviometría durante el período de riego.

Valores de ARIS inferiores a 1 indican riego deficitario, es decir, que se ha aportado menos agua que la estrictamente necesaria para la producción máxima. En estas condiciones, los valores bajos de eficiencia en el uso del agua podrían estar relacionados con un rendimiento muy bajo (kg ha^{-1}) y la parcela recibirá la misma calificación que cuando la eficiencia en el uso del agua esté en el intervalo 3-6 kg m^{-3}. Además, se dará un punto adicional cuando las parcelas cuenten con varios medidores de agua que delimiten las zonas de riego.

- Indicadores del momento en que ocurre el estrés hídrico.

El ahorro o la alta productividad del agua no equivalen a una correcta programación del riego. El RDC implica incluir en la programación la descripción de la fenología del cultivo y el control del estrés hídrico. En este sentido, el índice hidroSOS evalúa el período de restricción hídrica considerando la duración y el efecto en el consumo de agua. El período de déficit se prolongará hasta la última semana de agosto (hemisferio norte) o febrero (hemisferio sur). Las puntuaciones máximas se obtendrán cuando se estime el período según Rapoport *et al.* (2013) y este finalice en la última semana de agosto/febrero. Sin embargo, algunas parcelas podrían estar muy limitadas en la disponibilidad o la cantidad de agua, por lo que están obligadas a reducir este período de estrés hídrico. En este caso, la puntuación será menor cuando la recuperación sea en la segunda semana de agosto/febrero o en la última semana de julio/enero. También se considerará el ahorro de agua durante este período fenológico. Las puntuaciones máximas se obtendrán cuando el agua aplicada en este período represente más del 50 % de ahorro en comparación con las necesidades hídricas, pero también se considerará un porcentaje de ahorro del 50-30 % y del 20-10 %.

- Indicadores del nivel de estrés hídrico

El ahorro o la alta productividad del agua, durante un período de déficit particular, no significa que los productores controlen la cantidad aplicada de esta de manera precisa. La programación del riego deficitario real implica que los cultivos estén en condiciones de déficit hídrico en el momento adecuado y que los agricultores controlen los cambios en el estado hídrico del suelo/árbol. En el caso del olivo, durante la fase de endurecimiento del hueso, los niveles de estrés hídrico entre -2 y -3,5 MPa (potencial hídrico del tallo al mediodía) son exitosos si el período de recuperación es eficiente (Dell'Amico *et al.*, 2012; Girón *et al.*, 2015). Por tanto, el enfoque hidroSOS evalúa la gestión de la programación del riego y el nivel de estrés hídrico.

- Indicadores utilizados. Todas las mediciones en la parcela que describan las condiciones del estado hídrico suelo-planta recibirán las calificaciones máximas. El uso de modelos de cultivo es evaluado positivamente, pero con calificaciones más bajas que los indicadores utilizados a nivel de parcela. Las mediciones climáticas solo se considerarán si se incluyen en los modelos de cultivos.

- Frecuencia de medida. Las mediciones continuas (frecuencia inferior a 2 h) reciben la máxima puntuación. Las mediciones discontinuas se consideran solo si la frecuencia es inferior a 15 días durante el período de endurecimiento masivo del hueso y de entre 15 y 30 días durante el resto de la temporada de riego.

- Plan de muestreo. Las medidas anteriores son útiles cuando se monitorea una parte representativa de la parcela. Por tanto, la superficie considerada y el número de mediciones son factores clave para un muestreo preciso. Las parcelas se dividirán en zonas de muestreo con una superficie máxima de 20 ha (Shackel, 2018). La división de muestreo porcentual de la parcela se evaluará positivamente, el 100 % recibirá la puntuación máxima, pero también se puntuará cuando se muestre del 100-75 %, del 75-50 % y del 50-25 %. Adicionalmente, estas zonas se caracterizan por los árboles medidos: se obtendrán las máximas calificaciones con metodologías que cubran el 100 % de árboles de cada zona; se darán puntos positivos a las mediciones que cubran el 80-100 % de los árboles de cada zona o que utilicen al menos 10 árboles medidos en caso de metodologías aplicadas a árboles individuales.

- Medida del nivel de estrés hídrico. Las técnicas de cámara de presión son el punto de referencia para comprobar el nivel de estrés hídrico de la parcela. El potencial hídrico del tallo al mediodía se medirá en 5 a 10 árboles que representen la carga de frutos promedio en la parcela. Cuando la superficie de la parcela sea superior a 50 ha o la carga de frutos sea poco homogénea, solo se considerarán las zonas de alta carga de frutos. El manejo de la parcela se evaluará positivamente si el potencial hídrico del tallo promedio se encuentra entre -2 y -3,9 MPa. En el caso de parcelas jóvenes se aceptarán valores de potencial hídrico del tallo al mediodía superiores a -2 MPa.

Etiqueta Índice de Riego HidroSOS

La suma de todos los indicadores considerados permite clasificar las parcelas en un sistema de 4 etiquetas según la potencial sostenibilidad de la gestión del agua. El índice hidroSOS no cuantifica la sostenibilidad del sistema en términos de cantidad de recursos hídricos o ganancias económicas, lo cual sería muy difícil y no está suficientemente avalado en la bibliografía. Este índice evalúa los esfuerzos de los productores para optimizar el agua disponible para ellos. Asimismo, este índice podría ayudar al consumidor a identificar las empresas que están objetivamente más involucradas en la preservación de los recursos hídricos. La suma de todos los indicadores resultó en 105 puntos (**Tabla 1**), la etiqueta más alta (A, HYDROSOS) requerirá obtener más de 85 puntos. La etiqueta A significa que los indicadores hidráulicos (25 puntos en total), los indicadores no relacionados con la programación del riego (20 puntos), y los indicadores de programación de riego (60 puntos) deben estar en niveles máximos. La etiqueta B indica una parcela donde los esfuerzos de los productores son importantes (entre 65 y 85 puntos). La etiqueta C, entre 50 y 65 puntos, representa una parcela con importantes deficiencias desde el punto de vista de la sostenibilidad del riego, pero, nuevamente, se han evaluado positivamente algunos indicadores de programación del riego. Finalmente, la Etiqueta D, por debajo de 50 puntos, indica una parcela donde la programación del riego es casi nula y probablemente el manejo y el mantenimiento del riego también son muy deficientes (**Figura 6**).

Tabla 1. Puntuaciones de los componentes del índice de riego de hidroSOStenibilidad.

INDICADOR	DESCRIPTOR	PUNTOS
Indicadores hidráulicos		
Tipo de riego	Goteo/Microaspersión	5
Número y caudal de emisores	0,8-1,2 mm h^{-1} (Evapotranspiración diaria)	10
Frecuencia riego	1-3 días	5
Uniformidad en la distribución	95 %	5
	90 %	2
Indicadores agronómicos		
Procedencia del agua de riego	Reutilizada 100 %	5
	Reutilizada 75-100 %	4
	Reutilizada 50-75 %	3
	Reutilizada 25-50 %	1
*Adicional	Diques para almacenar lluvia	3
Manejo del suelo	Con cubierta	5
	No laboreo	2
Calidad del agua de riego	Análisis anual salinidad	1
Eficiencia del uso del agua	> 6 kg m^{-3}	5
	3-6 kg m^{-3}	2
	< 3 kg m^{-3}	0
*Adicional	Medidores de agua en 2 o más puntos	1
Uso de estimadores	Decidir el momento de reducción del riego	5
Duración del riego deficitario	Hasta la última semana de Ago./Feb.	5
	Hasta la segunda semana de Ago./Feb.	2
	Hasta la última semana de Jul./Ene.	1
Ahorro de agua aplicada	> 50 %	10
	30-50 %	7
	30-40 %	5
	10-20 %	2
Indicadores utilizados	Suelo-planta	5
	Modelos de cultivo	2
Frecuencia de medida	Continua	10
	Discontinua	8
Plan de muestreo	100 % superficie	10
	75-100 % superficie	8
	50-75 % superficie	4
	25-50 % superficie	2
Número de medidas	100% superficie	10
	80 % superficie o 10 puntos por zona	8
Medida del nivel de estrés hídrico	Ψ entre -2 y -3,9 MPa	5
	PUNTUACIÓN MÁXIMA	**105**

Etiqueta A (> 85 puntos). Parcela hidroSOStenible con un manejo del agua de riego permanente a nivel de parcela y un diseño hidráulico adecuado.
Etiqueta B (entre 65-85 puntos). Parcela que realiza un esfuerzo por controlar los recursos hídricos, pero que precisa de alguna mejora para considerarse realmente hidroSOStenible.
Etiqueta C (entre 50-65 puntos). Parcela con importantes deficiencias en el manejo del agua.
Etiqueta D (< 50 puntos). Parcela con ningún interés en la conservación de los recursos hídricos.

Figura 6. Clasificación de las 4 etiquetas del índice de riego de hidroSOStenible.

1.4.2. Índice de calidad HidroSOS.

El índice de calidad de HidroSOS incluye diferentes indicadores que permiten aplicar la estrategia de déficit de riego y mejorar la calidad de la fruta y los alimentos elaborados. Estos indicadores se agrupan en cambios químicos y sensoriales influenciados únicamente por el RDC y aquellos cambios influenciados por el procesamiento de la fruta. Este enfoque se debe al hecho de que el procesamiento de las aceitunas para obtener aceitunas de mesa y aceite de oliva altera los atributos fisicoquímicos y organolépticos (García *et al.*, 2013; Sakouhi *et al.*, 2008).

Los métodos señalados como idóneos para el análisis de los indicadores fueron aquellos ampliamente utilizados por los miembros expertos de los grupos de investigación participantes en los proyectos anteriormente mencionados y los comúnmente utilizados en la bibliografía (Cano-Lamadrid *et al.*, 2015; Fernandes-Silva *et al.*, 2013; ISO-12966-2, 2017; ISO-12966-4, 2015). Sin embargo, se pueden utilizar otros métodos estandarizados, proporcionando resultados similares y válidos.

- Principales conceptos a considerar para el Índice de Calidad HidroSOS.

La calidad y propiedades organolépticas de las aceitunas y su contenido en aceite están influenciadas por la implementación de buenas prácticas agronómicas. El concepto clave en el índice de riego hidroSOS es que se ha utilizado una gestión de riego adecuada, como la estrategia de riego deficitario controlado (RDC). Para obtener una RDC exitosa es necesario monitorear la fenología del cultivo, en el caso del olivo, y controlar el nivel de estrés hídrico alcanzado (utilizando diferentes métodos como la técnica de la bomba de presión) y la duración de ese déficit hídrico. En los olivos, una restricción hídrica moderada aplicada durante el

endurecimiento del hueso, cuando la resistencia al déficit hídrico del suelo es mayor (Girón *et al.*, 2015; Moriana *et al.*, 2003), permite ahorrar agua, sin afectar el rendimiento y el peso del fruto y maximizando el beneficio de los productores (Goldhamer, 1999; Moriana *et al.*, 2013).

- Elaboración de aceite de oliva virgen extra (AOVE) y aceitunas de mesa

Extracción de aceite de oliva virgen extra (AOVE). El aceite de oliva virgen es el producto obtenido exclusivamente por medios mecánicos o físicos (R1308/2013). Además, y para ser considerado aceite de oliva "virgen extra" (AOVE), debe cumplir dos requisitos: (i) tener una acidez libre máxima (<0,8 g de ácido oleico por 100 g) (R299/2013) y (ii) tener un Perfil sensorial que recuerda al de la aceituna recién recogida y sin defectos (Collado-González *et al.*, 2016). En los estudios en cuyos datos nos basamos, el AOVE se extrajo mediante un sistema Abencor y el aceite obtenido fue separado por decantación. Las muestras de aceite se filtraron y almacenaron en botellas de vidrio ámbar, sin espacio de cabeza, a -18 °C en la oscuridad hasta el análisis.

Procesamiento de Aceitunas de Mesa. El estilo español es el proceso industrial más popular para producir aceitunas de mesa (Sánchez-Gómez *et al.*, 2006). Este proceso consiste en un tratamiento de blanqueo inicial seguido de fermentación de ácido láctico, después de la adición de la salmuera (Malheiro *et al.*, 2014; Ramírez *et al.*, 2015). Durante las diferentes etapas de este proceso, se producirán cambios en la composición bioactiva de las aceitunas. Por ejemplo, durante el tratamiento alcalino, tanto la rutina como el luteolin-7-glucósido disminuyen, mientras que aumenta el ácido *p*-cumárico. El siguiente paso del proceso es la fermentación, donde el contenido de hidroxitirosol aumenta significativamente al principio, pero permanece prácticamente constante durante la etapa de fermentación (Brenes *et al.*, 1995). Además, para los polifenoles, el α-tocoferol y los ácidos grasos también pueden disminuir durante el procesamiento de la aceituna (Sakouhi *et al.*, 2008). Sin embargo, a pesar de todos estos cambios en la aceituna y su composición debido al procesamiento, los factores ambientales también pueden influir en estos cambios. Varios estudios han demostrado que el déficit hídrico afecta el contenido de ácidos grasos y en menor medida la composición de los compuestos volátiles. Debido a estos cambios químicos que ocurren en las aceitunas, sus características organolépticas se alteran (Cano-Lamadrid *et al.*, 2017; Cano-Lamadrid *et al.*, 2015; Ozdemir, 2016; Sakouhi *et al.*, 2008).

Desde el punto de vista de la calidad, la suma del conjunto de todos los indicadores considerados clasifica los productos bajo control en 4 etiquetas, de acuerdo con la sostenibilidad potencial alcanzada en la gestión del agua. Este índice evalúa si el estrés hídrico que los agricultores han aplicado a la parcela ha sido adecuado desde el punto de vista de la sostenibilidad y ha sido lo suficientemente fuerte como para afectar significativamente también la composición y el perfil sensorial de los productos comerciales finales (AOVE y/o aceitunas de mesa). Además, el logo que representa a este índice ayudará al consumidor a identificar aquellos productos que provienen objetivamente de una empresa involucrada en la preservación de los recursos hídricos. La suma de las puntuaciones de todos los indicadores evaluados es de 20 puntos para AOVE y 25 puntos para aceitunas de mesa (**Tablas 2 y 3**).

La etiqueta más alta, Etiqueta A, indica un producto totalmente hidroSOS, para lo que es necesario obtener más de 17 puntos en AOVE y más de 21 puntos en aceitunas. Para obtener la certificación, los AOVE hidroSOS deben tener un aumento de intensidad significativa de atributos positivos: amargor, picante y especialmente afrutado (>10 % en los 3 atributos). Asimismo, tendrán la puntuación más alta en este apartado si presenta un aumento de ácido oleico superior al 5 % y una disminución de ácido linoleico superior al 10 % y aumentos simultáneos superiores al 30 % y al 20 % en TPC y oleuropeína, respectivamente, en comparación con las muestras de control (Rinaldi *et al.*, 2011; Tovar *et al.*, 2001). Las aceitunas procesadas deben contar con un incremento superior al 10 % en la intensidad del sabor a aceituna verde y postgusto, además de un incremento superior al 15 % de ácidos grasos poliinsaturados (AGPI) y una disminución de ácidos grasos monoinsaturados (AGMI). Según la literatura, la aplicación de RDC en aceitunas de mesa conduce a un aumento de AGPI y una disminución de AGMI (Cano-Lamadrid *et al.*, 2015; Cano-Lamadrid *et al.*, 2017; Pierantozzi, 2012). La etiqueta B se otorgará a aquellos productos que obtengan puntuaciones totales en el rango de 16,9-13,0 puntos para AOVE y 20,9-16,0 puntos para frutos de aceituna de mesa. Esta etiqueta (B) indica un producto final que tiene una calidad sensorial mejorada y una buena composición bioactiva, pero no alcanza la calidad esperada para un producto cultivado bajo una RDI suave/moderada. Dado este resultado, se debe aplicar un mejor programa de riego para lograr un estrés hídrico moderado. Es importante mencionar que un estrés demasiado severo puede conducir a una composición similar a la de los productos de control o peor aún debido a un colapso del metabolismo de la planta. La etiqueta C alcanza valores entre 12,9-10,0 puntos para el AOVE y 15,9-12,5 para la aceituna de mesa, lo que representa productos finales con algunos resultados negativos, especialmente los relacionados con el contenido de compuestos bioactivos. En este

caso, es posible que la calidad sensorial comience a dar una respuesta negativa con respecto a los resultados esperados. A la vista de esto, se propondría realizar un nuevo programa de riego para lograr una mejora en el RDC aplicada. Finalmente, la Etiqueta D, está por debajo de <10 puntos en AOVE y <12,5 en aceitunas de mesa, lo que indica que los productos finales no han mejorado su calidad como consecuencia del RDC, tanto en los análisis de compuestos bioactivos como en los perfiles sensoriales. Los puntajes de la Etiqueta D son indicativos de que la RDI no se está aplicando o se aplica en las etapas incorrectas del ciclo de la planta o se alcanza intensidades demasiado intensas o suaves (**Figura 7**).

Tabla 2. Puntuaciones de los componentes del índice de calidad de hidroSOStenibilidad para aceite de oliva virgen extra (AOVE). TPC: compuestos fenólicos totales.

INDICADOR	DESCRIPCIÓN	PUNTUACIÓN
Atributos Sensoriales: amargo, picante y afrutado	> 10 % en los 3 atributos	5
	> 10 % en 2 atributos	4
	> 10 % en solo 1 atributo	2
Ácidos grasos	↑ > 5 % en ácido oleico y ↓ > 10 % en ácido linoleico	5
	↑ 4,9-3 % en ácido oleico y ↓ > 9,9-7 % en ácido linoleico	4
	↑ 2,9-1 % en ácido oleico y ↓ > 6,9-5 % en ácido linoleico	3
	↑ < 1 % en ácido oleico y ↓ < 5 % en ácido linoleico	2
Compuestos fenólicos	↑ > 30 % en TPC y > 20 % en oleuropeína	10
	↑ > 30 % en TPC y 19,9-15 % en oleuropeína	9
	↑ 29,9-20 % en TPC y 14,9-10 % en oleuropeína	8
	↑ 19,9-10 % en TPC y 9,9-5 % en oleuropeína	5
	↑ 9,9-5 % en TPC y 4,9-2,5 % en oleuropeína	3
	PUNTUACIÓN MÁXIMA	**20**

Tabla 3. Puntuaciones de los componentes del índice de calidad de hidroSOStenibilidad para aceituna de mesa procesada. AGPI: ácidos grasos poliinsaturados; AGMI: ácidos grasos monoinsaturados.

INDICADOR	DESCRIPCIÓN	PUNTUACIÓN
Atributos Sensoriales: sabor a aceituna verde y postgusto	↑ > 10 % en los 2 atributos	10
	↑ 9,9-7,5 % en los 2 atributos	7,5
	↑ 7,4-5 % en los 2 atributos	5
	↑ 4,9-2,5 % en los 2 atributos	2,5
Ácidos grasos	↑ > 15 % en AGPI y ↓ > 4 % en AGMI	15
	↑ 14,9-10 % en AGPI y ↓ 3,9-2 % en AGMI	10
	↑ 9,9-5 % en AGPI y ↓ 1,9-0,5 % en AGMI	5
	↑ < 5 % en AGPI y ↓ < 0,5 % en AGMI	2
	PUNTUACIÓN MÁXIMA	**25**

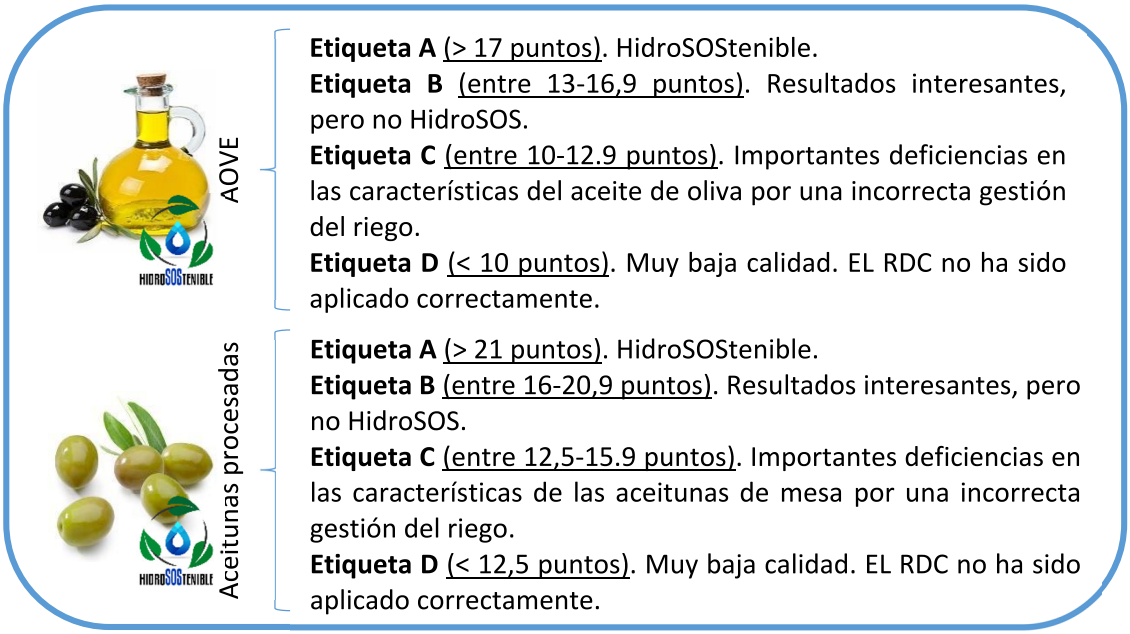

Figura 7. Clasificación de las 4 etiquetas del índice de calidad hidroSOStenible para aceite de oliva virgen extra (AOVE) y aceitunas procesadas.

Ambos índices de riego son complementarios y solo un aceite de oliva virgen extra (AOVE) o aceituna de mesa se puede etiquetar como hidroSOS, si cumplen 2 condiciones: (i) cumplen las condiciones establecidas en el índice de riego hidroSOS y (ii) cumplen con los requisitos del índice de calidad hidroSOS. El empleo de este índice proporcionará al agricultor una diferenciación y les permitirá su adaptación hacia las nuevas demandas del consumidor.

1.5. *Implicación del consumidor*

La sostenibilidad ambiental, social y cultural y económica están vinculadas a las consecuencias del consumo (Brinkmann y Peattle, 2008). Entonces, parece claro que la sostenibilidad está fuertemente vinculada con la forma en que las personas consumen y, por lo tanto, con la forma en que se fabrican los productos. En este sentido, el consumo y la producción sostenibles se definen, según el PNUMA (2011), como un "enfoque holístico para minimizar los impactos ambientales negativos de los sistemas de consumo y producción, al tiempo que se promueve la calidad de vida para todos". Paavola (2001) centró la definición en consumo sostenible como "consumo que implica una reducción del impacto adverso sobre el medio ambiente".

El consumo, la distribución y la producción de alimentos son aspectos clave del estilo de vida humano. Existen varios estudios sobre la relación entre el consumo de alimentos y la

sostenibilidad (Paloviita, 2010; Siegrist y Hartmann, 2019; Siegrist *et al.*, 2015; Steenis *et al.*, 2017; Verain *et al.*, 2016). Por lo tanto, está claro que los consumidores tienen un papel importante en hacer que las cadenas alimentarias sean más sostenibles a través de las elecciones que hacen al comprar alimentos porque brindan información a los productores sobre qué alimentos, cómo y dónde deben producirse (Poore y Nemecek, 2018). Si bien la forma en que se producen los alimentos puede modificarse mediante la legislación, las fuerzas del mercado son un motor importante en el desarrollo de las cadenas alimentarias (Grunert, 2011).

Los patrones de consumo sostenible dependen de cuáles son las percepciones sobre la sostenibilidad que tienen los consumidores y cómo estas percepciones crean actitudes y estas actitudes afectan a su comportamiento. La **percepción** del consumidor puede entenderse como la traducción de la percepción sensorial en el comportamiento de compra. En este sentido, la percepción sensorial está vinculada a la forma en que los humanos perciben y procesan los estímulos sensoriales a través de los sentidos, pero no solo. La percepción del consumidor también se relaciona con la forma en que se emiten las opiniones sobre las empresas y sus productos. En la otra dirección, las empresas utilizan la teoría de la percepción del consumidor, en primer lugar, para comprender lo que los consumidores piensan acerca de ellos y sus ofertas y, en segundo lugar, para desarrollar estrategias de comunicación para fijar a los consumidores actuales y atraer nuevos.

Como la sostenibilidad está vinculada al medio ambiente, se puede decir que la percepción sobre la sostenibilidad está relacionada con la preocupación ambiental. Este concepto se puede definir como "la percepción y la convicción de un individuo de que los humanos ponen en peligro el medio ambiente natural combinado con la voluntad de protegerlo" (Fransson y Gärling, 1999). Los investigadores usan este término para referirse a toda la gama de percepciones, emociones, conocimientos, actitudes, valores y comportamientos relacionados con el medio ambiente (Bamberg, 2012). Entonces, la preocupación ambiental vincularía percepciones, actitudes y comportamientos. Este concepto contiene, según Franzen y Vogl (2013), al menos, tres aspectos: (i) la conciencia racional del problema, (ii) el afecto emocional causado por el problema y (iii) la voluntad de actuar para resolverlo.

La **preocupación** medioambiental puede analizarse como una conciencia de las consecuencias, utilizando la teoría de activación del estándar de Schwartz (1977) del altruismo. Las evidencias empíricas muestran que la preocupación ambiental tiene efectos importantes en el comportamiento proambiental y, por lo tanto, en las percepciones y actitudes de sostenibilidad. En este sentido, induciría un sentido de responsabilidad, un compromiso de

comportarse bajo reglas personales u obligaciones morales que conducen a acciones de protección ambiental (Kumar *et al.*, 2017). Las normas proambientales reflejan el grado en que una persona siente la obligación personal de contribuir a la solución de un problema ambiental (Stern, 2000).

Las **actitudes** sobre los problemas ambientales dependen de la importancia relativa que una persona se atribuye a sí misma, a la humanidad y al planeta entero (Klöckner, 2013). Según Stern y Dietz (1994), estas actitudes pueden estar vinculadas a las consecuencias ambientales, etiquetadas como consecuencias egoístas, social-altruistas y biosféricas y relacionadas con tres orientaciones de valores subyacentes diferentes. Por lo tanto, se puede decir que las preocupaciones ambientales surgen porque las personas se dan cuenta de las consecuencias nocivas de algo que valoran. Sin embargo, esta conciencia dependerá de las percepciones de las personas. Estas percepciones desarrollarán las actitudes y valores de las personas.

Un aspecto importante que deriva de los valores es la confianza. La confianza generalmente se entiende como una situación caracterizada por los siguientes aspectos: una parte (fideicomitente) está dispuesta a depender de las acciones de otra parte (fiduciario); la situación se dirige al futuro. El fiduciario tiene el control ya sea porque el fideicomitente cedió ese control o, en el caso de muchos reclamos como ambientales o de sostenibilidad, porque el fideicomitente no tiene forma de confirmar la acción. Es una parte clave de cómo se crean los valores en una sociedad. En este sentido, se puede suponer que la confianza está vinculada a una fuerte preocupación por los problemas ambientales. Las personas muestran diferentes niveles de confianza hacia otras personas e instituciones. Confiar en otras personas aumenta la preocupación ambiental (Meyer y Liebe, 2010), ya que crea la creencia de que otros también están preocupados por los problemas ambientales y ayudan a proporcionar y mantener bienes públicos. Según esto, confiar en las instituciones públicas también debería influir en la preocupación ambiental de las personas. Sin embargo, esto no está tan claro, por lo que se deben abordar dos preguntas. Primero, las instituciones públicas son responsables de proporcionar bienes públicos. Las personas que no confían en las instituciones públicas podrían tender a pensar que los problemas ambientales no se consideran adecuadamente. Además, las personas podrían estar menos preparadas para proporcionar bienes públicos cuando piensan que otros (instituciones públicas) no están cumpliendo sus tareas. Por lo tanto, este no es un aspecto resuelto y lo más importante, depende de las percepciones de las personas sobre la sostenibilidad (Meyer y Liebe, 2010).

Es interesante observar las diferencias personales y nacionales con respecto a la preocupación ambiental y sus percepciones y actitudes sobre la sostenibilidad. En este sentido, la preocupación ambiental está fuertemente relacionada con la riqueza de la nación. Las personas que viven en países más ricos muestran una mayor preocupación ambiental. La riqueza de un país tiene un efecto positivo en la preocupación ambiental de las personas (Klöckner, 2013).

Sin embargo, las diferencias individuales dentro de un país están más definidas que las diferencias entre países. Según Franzen y Vogl (2013), la preocupación ambiental de las personas se basa en características sociodemográficas como el género, la edad, los ingresos y la educación. Además, la preocupación ambiental también está vinculada a la confianza general en los demás, la afiliación a un partido y los valores posmateriales. Las mujeres están más preocupadas que los hombres. Esto podría explicarse mirando diferentes roles sociales. Las personas más jóvenes muestran una mayor preocupación que las personas mayores, ya que crecieron en momentos en que los medios de comunicación prestaron más atención al problema. Sin embargo, la preocupación ambiental aumenta primero y disminuye a medida que las personas envejecen. El nivel de ingresos también está relacionado con la preocupación ambiental. Cuanto mayor sea el ingreso, mayor será la preocupación por los problemas ambientales. Esto puede explicarse mirando dos hechos. Primero, las personas más ricas tienen menores o nulos problemas económicos, por lo que pueden plantearse otras cuestiones. En segundo lugar, las personas con mayores ingresos suelen tener un mayor consumo de bienes privados y una mayor demanda de bienes públicos. Presentan una mayor disposición a pagar por mejores bienes públicos. Finalmente, la educación está directamente relacionada con la preocupación ambiental (Zsóka *et al.*, 2013). Cuanto mayor es el conocimiento sobre los problemas ambientales, mayor es la preocupación.

Según la hipótesis de posmaterialismo de Inglehart (Inglehart, 2020), las orientaciones de valor también están relacionadas con la preocupación ambiental. Esta teoría propone que las sociedades enfrentan cambios a medida que se desarrollan económicamente. Las crisis económicas crean generaciones con valores materialistas más altos (por ejemplo, crecimiento económico, estabilidad de precios). Las generaciones que crecen en prosperidad económica muestran valores posmateriales más fuertes (libertad y autorrealización). Los valores posmateriales están positivamente vinculados a la preocupación ambiental, ya que la prosperidad económica no es una cuestión a resolver.

La preocupación ambiental se convierte en “comportamiento proambiental” cuando las personas deciden actuar. Existen varios tipos de comportamiento proambiental. Los determinantes de la acción y su influencia son variados. Un grupo de comportamientos ambientales están vinculados a la idea de frugalidad (reducción de uso, reciclaje y reutilización de objetos) (Fujii, 2006). La actitud frugal está vinculada al comportamiento cooperativo en los dilemas de recursos, o el comportamiento de conservación de recursos (Wilke, 1991). Requiere motivaciones para ahorrar recursos, una idea de "eficiencia" y una fuerte confianza en otras personas. Obviamente, estas motivaciones dependen de las percepciones y actitudes sobre la sostenibilidad.

Por lo tanto, el consumo sostenible de alimentos debe entenderse como un comportamiento que depende de las percepciones sobre lo que compra un consumidor y cómo la producción y la distribución afectan al medio ambiente. Estas percepciones pueden conducir a actitudes que son la etapa previa al comportamiento. Es por eso que observar las percepciones de las personas sobre la sostenibilidad es un factor clave para comprender cómo y por qué compran, ya que el abuso que se ha hecho de este término ha imposibilitado una visión clara por parte del consumidor de lo que realmente es un producto sostenible. De hecho, desde 1987 que fue definida la sostenibilidad por primera vez, se ha ido incrementado la investigación y producción científica sobre este tema hasta alcanzar más de 26.000 artículos científicos publicados en 2019 (Figura 8; Elsevier, 2020).

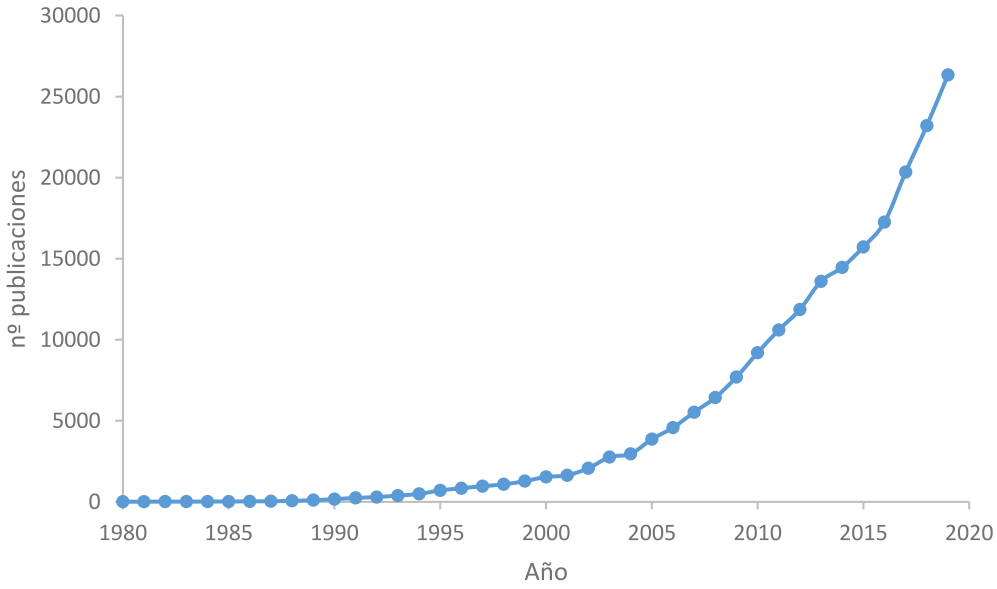

Figura 8. Evolución de las publicaciones científicas sobre sostenibilidad (Elsevier, 2020).

Es un hecho que cuanto más local (mayor cercanía a la producción) y más estacional (producto de temporada) es un producto alimenticio, más sostenible es, en cambio, la mayoría de la población lo desconoce. Como se ha comentado, cambios en la dieta pueden generar beneficios ambientales en una escala que los productores no pueden lograr (Poore y Nemecek, 2018). Los consumidores pueden jugar otro papel importante evitando comprar a los productores de alto impacto (Grunert, 2011). Esta acción necesita conciencia previa y la conciencia depende de las percepciones y actitudes. Por lo tanto, comunicar el impacto promedio de los productos a los consumidores es el primer paso para hacer posible un cambio en la dieta, ya que puede ayudar a cambiar las percepciones y, por lo tanto, las actitudes.

Los productores y la sociedad necesitan saber cuáles son estas percepciones y actitudes y cuáles son los principales grupos con ideas equivocadas sobre sostenibilidad para desarrollar estrategias efectivas de comunicación.

1.6. *Etiquetado Sostenible*

El etiquetado sostenible es un distintivo para aquellos productos que originan sobre el medio ambiente un impacto menor que el de los productos similares. El objetivo fundamental de estas etiquetas es vincular al producto con su proceso productivo (Wessells *et al.*, 2001).

En Conferencia de las Naciones Unidas sobre Medio Ambiente y Desarrollo se reconoció que el etiquetado sostenible es potencialmente útil para crear incentivos de mercado en aquellos productos y procesos que sean amistosos hacia el medio ambiente y, posteriormente, se acordó fomentar la difusión de este etiquetado y de otros relacionados con la información ambiental del producto, y que permitan al consumidor a elegir en forma consciente (Deere, 1999; Wessells *et al.*, 2001).

Hoy en día, existen multitud de logotipos o etiquetas referentes a aspectos sostenibles (**Figura 9**). Estas etiquetas nos aportan información sobre características medioambientales de los productos (calidad, procedencia, etc.). Entre ellas podemos encontrar: la etiqueta de comercio justo o "*fairtrade*", cuyos objetivos son, entre otros, que se mejore el desarrollo social, económico y medioambiental, garantizando que los productores reciben precios justos; la etiqueta de producción ecológica, mediante la que se demuestra que el producto es ecológico de acuerdo con la legislación europea (R2018/848; R834/2007); la etiqueta *Rainforest Alliance Certified*, mediante la cual se certifica el producto está disminuyendo la huella de carbono; o la etiqueta *Forest Stewardship Council* o Consejo de Administración Forestal, que fomenta una

gestión forestal responsable con el medio ambiente (contribuyendo a la protección de bosques, a la fauna y a la flora y ayudando al sector agrario), sostenible y beneficiosa económicamente.

De esta forma, los consumidores son estimulados a consumir productos con menores repercusiones medioambientales. Sin embargo, aunque los consumidores demandan cada vez más alimentos producidos de manera sostenible y muchos están tratando de lograr un cambio, existe un desconocimiento generalizado (Malochleb, 2018). Por este motivo, transmitir la información correctamente y valorar si se cumple o no con las expectativas, tanto del consumidor como del fabricante/productor es cada vez más necesario.

Figura 9. Etiquetas de sostenibilidad empleadas actualmente. De izquierda a derecha y de arriba abajo: *Fairtrade* (comercio justo), FSC (gestión forestal), UTZ (café, cacao, te y frutos secos), *Rainforest Alliance Certified* (huella de carbono), hoja verde (producción ecológica), RSPO (aceite de palma) y MSC (pesca).

Desarrollar sistemas de identificación de prácticas y productos sostenibles, se convierte en un punto clave para conseguir la implicación de consumidor en el proceso y así alcanzar un futuro sostenible. Por tanto, identificar la percepción de los consumidores sobre la sostenibilidad de los alimentos es esencial y resulta de utilidad para educar e informar al consumidor, el cual puede modificar su comportamiento de compra a favor de una producción más sostenible.

OBJETIVOS

2

El principal objetivo de esta Tesis Doctoral fue definir e identificar los segmentos de consumidores europeo, americano y asiático para informar de forma adecuada sobre la sostenibilidad e hidroSOStenibilidad.

MATERIALES Y MÉTODOS

3

3.1. Estudios de consumidores

Los estudios de consumidores se realizaron mediante encuestas *on-line* (Anexo I), realizadas a través de la plataforma Qualtrics (Provo, UT, EE.UU.). Se seleccionaron 6 países (Estados Unidos, China, México, Brasil, España e India) en función de la disponibilidad de bases de datos y con el fin de representar a países de gran población en 3 continentes (**Figura 10**). Qualtrics mantiene bases de datos de consumidores en cada país (generalmente con más de 1 millón de encuestados por país en todo el país y muchos más en algunos países como los Estados Unidos). Por supuesto, como con cualquier encuesta *on-line*, solo se utilizan aquellos consumidores que tienen acceso a internet y están disponibles. Los consumidores que están *on-line* y están accesibles son una parte cada vez más grande de la población, pero, aun así, en algunas partes del mundo este tipo de pruebas son imposibles. China, India, Estados Unidos y Brasil tuvieron el mayor número de usuarios de Internet en 2015 (México ocupó el séptimo lugar) y España tuvo uno de los porcentajes más altos de usuarios (Roser *et al.*, 2015). Sin embargo, como se ha mencionado anteriormente, algunas personas no tienen acceso y, por lo tanto, quedaron excluidas de esta encuesta. Las encuestas se lanzaron simultáneamente en los 6 países estudiados. Las preguntas seleccionadas para el estudio se establecieron mediante discusión de expertos y gracias a la colaboración entre *The Sensory Center of Kansas State Univertisy* y la Universidad Miguel Hernández de Elche.

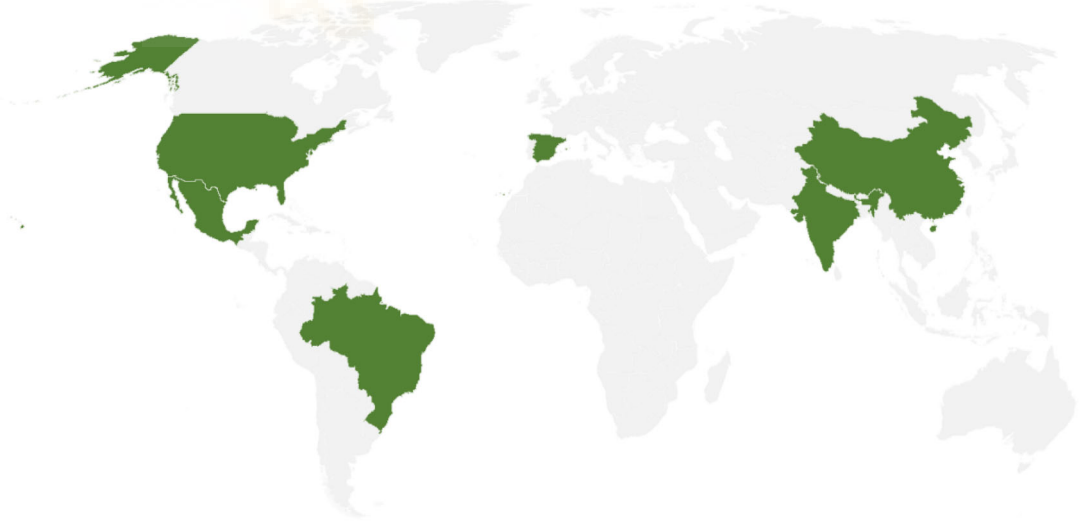

Figura 10. Países seleccionados para el estudio de consumidores.

En estos estudios se utilizó población general, dado que todas las personas consumen alimentos, por lo que no se consideró necesario el empleo de criterios específicos con respecto a los hábitos alimentarios o el comportamiento hacia el medio ambiente para calificar o elegir a los encuestados. La encuesta fue completada por más de 3600 consumidores (50 % de hombres

y 50 % de mujeres). Se seleccionaron cuatro rangos de edad (25 % de los participantes para cada rango de edad), claramente diferenciados: 18-23 años (*Centennials*); 24-41 años (*Millennials*); 42-52 años (Gen X) y 53-73 años (*Baby boomers*). Se evaluaron cinco niveles de estudios (estudios primarios o inferiores, estudios secundarios, bachiller, diplomatura o estudios universitarios sin terminar y licenciatura/grado universitario o superior) y 4 rangos de ingresos (25.000 dólares estadounidenses o menos, 25.001-50.000 dólares estadounidenses, 50.001-100.000 dólares estadounidenses y más de 100.000), con un 25 % de consumidores por cada nivel y rango. Para los ingresos, cada país presentó rangos adaptados (en la moneda oficial de cada país) con el fin de obtener resultados de las clases baja, media y alta de cada país. Los resultados por ingresos se han expresado en dólares estadounidenses. Los encuestados no recibieron un incentivo financiero para completar la encuesta, pero la base de datos de Qualtrics tiene un sistema de recompensas para compensar a los encuestados por su tiempo y colaboración. También se recopilaron datos demográficos para clasificar a los consumidores de acuerdo con los factores a estudiar (país, género, edad, educación, ingresos).

Se evaluó el concepto global de sostenibilidad y el de hidroSOStenibilidad. Las preguntas se organizaron diferentes niveles, como se describe a continuación:

(i) sostenibilidad general

(ii) disposición a pagar por diferentes categorías de alimentos

(iii) múltiples aspectos de la sostenibilidad de las categorías de alimentos

(iv) sostenibilidad del agua en categorías de alimentos

(v) identificación y etiquetado de productos hidroSOStenibles

Las encuestas se probaron previamente en inglés para garantizar que los consumidores pudieran completarla fácilmente y luego en los idiomas de los países participantes mediante un enfoque modificado de traducción, revisión, adjudicación, reevaluación y documentación (TRAPD) (Curtarelli y van Houten, 2018; Harkness *et al.*, 2003) descrito por Seninde y Chambers IV (2020), que incluye un paso de prueba previa en cada país. Las traducciones se hicieron para chino mandarín, español, portugués e hindi, y el logotipo también se tradujo a esos idiomas. La palabra "hydroSOStainable" se presentó junto con su traducción en India y China. La encuesta se realizó on-line y en cada país se presentó en su idioma oficial más común o en una selección de idiomas (ej.: inglés e hindi).

Para medir las respuestas, se utilizaron diferentes escalas: (i) escala tipo Likert de 7 puntos (1: totalmente en desacuerdo, 2: en desacuerdo, 3: en desacuerdo, 4: ni de acuerdo ni en desacuerdo, 5: de acuerdo, 6: de acuerdo, 7 totalmente de acuerdo); (ii) Check All That Applies

(CATA) para verificar todas aquellas declaraciones que los consumidores acordaron sobre productos sostenibles; (iii) Preguntas de clasificación y; (iv) Mapa de calor para evaluar las áreas de mayor visibilidad del logotipo.

3.2. Análisis estadístico

Para el análisis de los resultados se realizó un análisis de varianza unidireccional (ANOVA), la prueba de rango múltiple de Tukey y el análisis de Friedman, con la posterior prueba de LSD (diferencia mínima significativa). La fiabilidad se probó utilizando el alfa de Cronbach (confianza del 95 %), mientras que las preguntas se agruparon mediante el análisis de componentes principales (PCA), ambos se ejecutaron utilizando R (lenguaje de programación). También se usó el PCA para agrupar las preguntas y evitar preguntas similares. La distancia euclidiana por el método de aglomerado (método de Ward) se utilizó para preparar dendrogramas. Se utilizó el software XLSTAT (versión 2016.02.27444, Addinsoft). El intervalo de confianza fue del 95 % y la diferencia significativa se definió como p <0,05. Los datos no se ponderaron para representar todas las clases demográficas en un país porque se utilizaron números iguales de consumidores en cada categoría de sexo y edad para fines de comparación dentro y entre países. Se evaluó la visibilidad de las áreas del logotipo y se creó un "mapa de calor" que muestra las áreas que los consumidores habían resaltado.

PUBLICACIONES

4

PUBLICACIÓN 1

CONSUMER UNDERSTANDING OF SUSTAINABILITY CONCEPT IN AGRICULTURAL PRODUCTS

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Consumer understanding of sustainability concept in agricultural products

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ABSTRACT

The term "sustainability" is based on three main pillars: environment, society and economy. To achieve sustainable development, agriculture is one of the main fields to be considered and it is key to address economic, environmental and ethical problems. Besides, consumers are increasingly demanding foods produced under sustainable practices and aiming to get involved in the process of enhancing food sustainability. Under such premises, a study was carried out with more than 3600 consumers in 6 countries (Brazil, China, India, Mexico, Spain and USA). Participants were asked questions organized in two main topics: general sustainability and willingness to pay on different food categories. In general, results showed that consumers thought that a sustainable product is "environmentally friendly", "healthier", has been grown using "few chemicals" and "have better quality". More than 30% of consumers in the US and Spain were not willing to pay more for sustainable products. This percentage decreased to 20% in China, Mexico and Brazil and reached the lowest value in India (~14%). The main conclusion is that consumers are not fully aware of the importance of sustainability; in general, consumers tend to associate sustainable production with just organic farming and higher quality.

1. Introduction

One of the first definitions of sustainability was "ability to meet the needs of the present without jeopardizing the ability of future generations to meet their needs" (Burton, 1987). Today, sustainability is based on 3 main pillars which form the basis of sustainable development (i) environment, (ii) society and (iii) economy (Reisch, Eberle, & Lorek, 2013). These factors are mutually reinforcing and can be achieved by managing physical, natural and human capital (United Nations, 2012).

To achieve sustainable development, agriculture is one of the main fields to be considered and it is essential to address economic, environmental and ethical problems worldwide (Meyer-Höfer, 2014). Regarding water and energy, it is estimated that agriculture uses ~70% of the world fresh-water and the food sector consumes ~30% of energy worldwide (FAO, 2011; Jeswani, Burkinshaw, & Azapagic, 2015). In general, intensive agriculture poses serious risks for nature because, among other issues, it causes biodiversity loss, has extremely high freshwater consumption, contributes to climate change through greenhouse gas emissions, and greatly interferes with nitrogen and phosphate (N & P) cycle (Willett et al., 2019). The abusive use of N & P fertilizers has accelerated the processes of eutrophication, whereas the over-use of irrigation water has depleted aquifers and reduced river flows in certain regions, especially in those with intensive farming in arid- or semi-arid regions (Darré, Cadenazzi, Mazzilli, Rosas, & Picasso, 2019; McLaughlin & Kinzelbach, 2015).

Society is another key agent for sustainable development, with human health being the core of sustainability. Increasing crop yields by intensifying farming practices (e.g. super-high density olive farming) has contributed positively to life expectancy and hunger reduction (Steffen et al., 2015; Whitmee et al., 2015; Willett et al., 2019). However, enhanced food availability and societal changes towards ready-to-eat and fast food have led to diets high in calories based on over-consumption of products contributing to an environment degradation (Springmann, Godfray, Rayner, & Scarborough, 2016; Tilman & Clark, 2014; Willett et al., 2019). It is curious that these habits are favored by advances in society such as urbanization and the incorporation of women into work. Lower urban wages tend towards high intake of products such as fast food and/or ready-to-eat foods which tend to increase consumer's intake of salt, fat and sugar (Cohen & Garrett, 2010). To change this situation, the concept of "sustainable diet" arises,

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considering not only human health (nutrition) and environment, but also cultural, social and economic aspects (FAO, 2010; Green et al., 2018). In 2018, the percentage of consumers who considered sustainability in the food they ate as an important factor increased as compared to previous years (IFIC, 2018). For these reasons, being able to understand what consumers understand by sustainable food and sustainability is essential to change from less healthy to more sustainable diets in a proper way. To reach this goal without fraudulent practices or threating health and environment, certification systems can play a key role (Meyer-Höfer, 2014).

Finally, the economy must be part of sustainability. For this, society, the environment, future prospects, economic efficiency and justice between generations and between humans and nature must be taken into account (Baumgärtner & Quaas, 2010). The economy depends heavily on nature and, therefore, the economic activity must be limited by the "finite" capacity of the biosphere to regenerate resources and assimilate wastes. Consumers respond to economic incentives if commercial prices reflected environmental and social costs, they will act as incentives to improve sustainability, buy sustainable products and consequently will act as penalization against non-sustainable products (Glaser, 2010).

Thus, the aim of this study was to evaluate how the factors country, age, gender, income and education influence consumer understanding of the complex concept of sustainability and consumer willingness to pay for sustainable agricultural products.

2. Materials and methods

For this study, online surveys were conducted with the help of Qualtrics (Provo, UT, USA), who recruited consumers (n greater than 600) from each country, using already existing databases. A quota of 50% self-identified men and women were selected, within each of the 4 age ranges: (i) 18–23 years old, centennials; (ii) 24–41 years, millennials; (iii) 42–52 years, gen X; and, (iv) 53–73 years, baby boomers, with ~ 25% consumers per rank. Five levels of study were evaluated (primary school or less, high school diploma, associate's degree, bachelor's degree and graduate degree or higher) and 4 income ranges (25,000 US dollars or less, 25,001–50,000 US dollars, 50,001–100,000 US dollars and more than 100,000 US dollars), with 25% of consumers for each level and rank. For income, each country presented adapted ranges (in the official currency of each country) to obtain results from the lower, middle and upper classes of each country (in Spain: 10,000 euros or less, 10,001–25,000 euros, 25,001–50,000 euros, and more than 50,000 euros; in Brazil: 14,400 reals or less, 14,001–26,400 reals, 26,401–48,000 reals, and more than 48,000 reals; in Mexico: 48,000 pesos or less, 48,001–96,000 pesos, 96,001–240,000 pesos, and more than 240,000 pesos; in India: 25,000 rupees or less, 25,001–50,000 rupees, 50,001–100,000 rupees, and more than 100,000 rupees; and in China (Popa et al., 2019): 25,000 renminbi (yuan) or less; 25,001–50,000 renminbi (yuan), 50,001–100,000 renminbi (yuan), and more than 100,000 renminbi (yuan)). Results for income have been expressed in US dollars. The selected consumers were chosen from 6 countries (United States of America, Mexico, Brazil, Spain, China and India), because a diverse set of national identities was considered a very important factor for the study. Participants did not receive a financial incentive to complete the online survey, but the Qualtrics database has a reward system to compensate the respondents for their time and collaboration. Demographic data was also collected to classify consumers according to the factors to be studied (country, gender, age, education, income) (questions Q1, Table 1).

This study was included within a larger survey on water sustainability, but before going into more specific issues the global concept of sustainability was evaluated in the current study. Current questions were organized into two main topics with different levels, as described below:

(i) *general sustainability*, (questions Q2-Q3, Table 1) which was later divided into 6 subtopics:
   a) basic statements or definitions,
   b) benefits for local communities,
   c) sensory quality,
   d) price and purchase intention,
   e) health effects, and
   f) relevance to consumers;

(ii) *willingness to pay for different food categories*, e.g. tap water, food for special dietary uses, cheese, etc. (question Q4, Table 1) assuming equal liking/hedonics. Liking or hedonics was included in the question because variations of those terms have been shown to be the a critical factor in food choice in many countries (Grunert, 2018; Moraes, Moraes, Souza, & Alvarenga, 2020; Uyen T. X. Phan & Chambers, 2016; Uyen T.X. Phan & Chambers IV, 2016).

For questions Q2, a 7-point Likert-type scale was used (1: strongly disagree, 2: disagree, 3: disagree somewhat, 4: neither agree nor disagree, 5: agree somewhat, 6: agree, 7 strongly agree). For the question Q3 (Table 1), a Check All That Applies (CATA) format was used to check all those statements that consumers agreed on sustainable products. Finally, for question Q4 (Table 1) about willingness to pay the following options were available: pay 0, 5, 10, 20, 50, 100 or >100% more for sustainable products.

The survey was translated into five languages (English, Spanish, Portuguese, Hindi, and Mandarin Chinese). Verification of the translations was done through a retrospective or multiple translation process similar to that described by Seninde and Chambers IV (2020). The survey was conducted online and in each country was presented in its most common official language except India, where consumers were given the choice to complete the questionnaire in Hindi or English.

2.1. Statistical analysis

The results of the analyses were processed by means of a one-way analysis of variance (ANOVA) and by Tukey's multiple range test, with a confidence interval of 95%. It was decided to use ANOVA instead of MANOVA (multivariate analysis of variance) because due to the high number of questions to include and the high number of interactions that were needed. Furthermore, a Principal Component Analysis (PCA) was carried out. The software XLSTAT (2016.02.27444 version, Addinsoft) was used and the significant difference was defined at $p < 0.05$.

3. Results

The results obtained dealing with the concept of *general sustainability* are shown in Tables 2-4. As indicated before, the content of these four tables has been organized into 6 subsections: basic statements or definitions (basic knowledge), benefits for local communities, sensory quality, price and purchase intentions, health effect, and relevance to consumers.

Basic statements or definitions. The subtopic/category "basic statements" consists of questions (questions Q2, Table 1) regarding basic knowledge on the concept "sustainability", and specifically about its relationship with diet, animal welfare, intensive farming practices, food labelling, greenhouse gas emission and water use in agriculture.

It can be seen that Spanish and US consumers showed a neutral attitude (~4) in relation to the possibility of reducing gas emissions through a vegetarian diet (Q2.1), whereas Chinese consumers were the ones showing the highest agreement with this statement (5.6) (Table 2). Besides, Chinese consumers were the ones who presented the lowest concerns about animal welfare (Q2.2; 3.8); and China and India consumers, prefer conventional and highly automated agriculture (mean values of 5.2 and 5.0, respectively).

Similarly, Indian consumers agreed the most with the need to use

Table 1
Full questionnaire.

Number	Question
Q1	**Demographics**
Q1.1	What is your gender?
Q1.2	What is your age?
Q1.3	What is the highest education level you have completed?
Q1.4	How many adults live in your household including yourself?
Q1.5	How many children under the age of 18 are in your household?
Q1.6	How much is your approximate annual income?
Q2	**The survey that you are going to take is about food and the environment. Please indicate your agreement with the following questions.**
Q2.1	A vegetarian diet can reduce greenhouse gas emissions.
Q2.2	Assurance of animal welfare in food production is important to me.
Q2.3	Consuming products made from environmentally friendly grains is more expensive than consuming conventional products.
Q2.4	Consuming seasonal vegetables is environmentally friendly.
Q2.5	Conventional and highly automated farming leads to higher quality products.
Q2.6	Conventional fruits have the same nutrient and antioxidant content as organic fruits.
Q2.7	Intensive agriculture leads to reduced biodiversity which I find unacceptable.
Q2.8	Food/Gastronomic/Agricultural tourism can help the development and sustainability of small local farmers.
Q2.9	Greenhouse tomatoes have fewer nutrients because they contain more water.
Q2.10	I am willing to pay a slightly higher price for local foods.
Q2.11	The less food packaging the more sustainable the food.
Q2.12	I avoid buying processed food because it is not healthy.
Q2.13	I pay attention to environmental information on food labels.
Q2.14	I enjoy eating rain-fed vegetables because they are tastier than irrigated products.
Q2.15	I prefer buying food from local or nearby markets/producers.
Q2.16	I will avoid producers and products that I know have a high impact on the environment.
Q2.17	If the price is reasonable, I will buy foods produced using sustainable strategies.
Q2.18	I think cooking oils coming from plants grown with less water have a healthier fatty acid profile than conventional cooking oils.
Q2.19	Food produced locally is fresher than those sold in supermarkets or hypermarkets.
Q2.20	Local products are more nutritious than other products because they are picked riper and are fresher.
Q2.21	Organic foods are better used by the body because they do not have chemicals.
Q2.22	Organic vegetables have a nice appearance and are uniform.
Q2.23	Reducing land use, fresh water consumption, and fossil fuels used in food production should be an important goal of food producers.
Q2.24	Small farmers are essential to guarantee farming sustainability in the world.
Q2.25	Social aspects of food production (for example, fair trade, social right of workers) are important to me.
Q2.26	Sustainable agriculture must be concerned with ensuring the economic viability of the farm and the farmer.
Q2.27	The price I pay for organic or more sustainable foods is worth it.
Q2.28	The volume of water needed to grow 1 lb of tomatoes is approximately the same as the amount needed to grow 1 lb of wheat.
Q2.29	World food production cannot be maintained through local products; intensive agriculture is needed.
Q2.30	Even if the price of organic products is slightly higher than that of conventional products, I will buy the organic products.
Q2.31	When I choose local foods, I reduce transporting and packaging costs.
Q3	**Please check all those statements on sustainable products you agree with**
	Highly sophisticated irrigation strategies are used in their production.
	I accept their higher price.
	I do not care too much about them.
	I have never heard about sustainable food products.
	I recommend their purchase to my family/friends.
	Sustainable chicken tastes better because birds have the best possible nutrition.
	More water is required in their production.
	The price of tomatoes is the same, no matter their sustainable origin.
	Their packaging is nice and labels come in bright colors.
	Their price is too high for me; I will not buy them.
	Their taste is similar to that of the conventional products.
	There are environmental friendly.
	There is a need for a logo that clearly identifies them.
	There are plenty of natural resources and they will be there for a long time.
	They are authentic because they ensure a proper future of agriculture.
	They are healthier.
	They are homogeneous in size and I like that.
	They are more expensive.
	They are packed using non-degradable plastics.
	They are produced in a more traditional way.
	I do not trust sustainable products.
	They are grown or produced with fewer chemicals.
	They are tastier.
	They increase my trust.
	They do not attract my attention.
	They have a poor flavor.
	They have better quality.
	They look natural.
Q4	**Assuming products at the same liking as your current products, I am willing to pay ___ % more money for more sustainable food products (choose the proper value for each food category)**
	Tap water.
	Food for special dietary uses.
	Miscellaneous.
	Cheese.
	Dairy based products.
	Milk and dairy based drinks.
	Eggs.
	Fish based preparations.
	Fish and fish products.
	Seafood and seafood products.
	Meat based preparation.
	Edible offal and offal products.
	Meat, meat products and substitutes.
	Other alcoholic beverages and substitutes.
	Wine and substitutes.
	Beer and substitutes.
	Coffee, tea and cocoa.
	Bottled water.
	Snack foods.
	Soft drinks.
	Fruit and vegetable juices.
	Fruits.
	Starchy roots and potatoes.
	Vegetables, nuts and beans.
	Vegetable soups.
	Fats (vegetable and animal).
	Sugar and sugar products including chocolate.
	Cereals and cereal products.
	Cereal-based mixed dishes.

Table 2
Consumers opinion on sustainability issues as affected by the "country" factor.

Question	ANOVA[†]	Country					
		USA	China	Mexico	Brazil	Spain	India
Basic statements							
Q2.1	***	4.2 ^{d,‡}	5.6 ^{a}	4.5 ^{c}	4.6 ^{c}	4.2 ^{d}	4.9 ^{b}
Q2.2	***	5.3 ^{b}	3.8 ^{c}	5.9 ^{a}	5.8 ^{a}	5.8 ^{a}	5.8 ^{a}
Q2.5	***	4.2 ^{c}	5.0 ^{a}	4.4 ^{b}	4.3 ^{bc}	4.0 ^{c}	5.2 ^{a}
Q2.11	***	4.5 ^{d}	3.9 ^{e}	5.3 ^{b}	5.1 ^{bc}	5.6 ^{a}	4.9 ^{c}
Q2.13	***	4.4 ^{c}	5.5 ^{a}	5.0 ^{b}	5.1 ^{b}	5.0 ^{b}	5.6 ^{a}
Q2.28	***	3.9 ^{a}	3.6 ^{b}	3.8 ^{a}	3.9 ^{a}	3.6 ^{b}	4.0 ^{a}
Q2.29	***	4.6 ^{d}	4.8 ^{bc}	5.1 ^{ab}	4.7 ^{cd}	4.8 ^{cd}	5.3 ^{a}
Benefits for local communities							
Q2.8	***	5.1 ^{d}	5.9 ^{ab}	6.1 ^{a}	5.8 ^{bc}	5.7 ^{c}	5.8 ^{bc}
Q2.24	***	5.6 ^{b}	5.2 ^{c}	6.0 ^{a}	5.9 ^{a}	5.9 ^{ab}	5.8 ^{ab}
Q2.25	***	5.1 ^{c}	5.4 ^{b}	5.8 ^{a}	5.8 ^{a}	5.8 ^{a}	5.7 ^{a}
Q2.26	***	5.5 ^{c}	6.0 ^{a}	6.0 ^{a}	5.7 ^{b}	5.8 ^{ab}	5.7 ^{bc}
Q2.31	***	5.4 ^{c}	5.6 ^{bc}	5.8 ^{ab}	5.9 ^{a}	5.6 ^{bc}	5.6 ^{bc}
Sensory quality							
Q2.14	***	4.4 ^{c}	4.4 ^{c}	4.7 ^{b}	4.4 ^{c}	3.9 ^{d}	5.2 ^{a}
Q2.19	***	5.5 ^{b}	5.1 ^{c}	5.9 ^{a}	5.7 ^{ab}	5.7 ^{ab}	5.8 ^{a}
Q2.20	***	5.1 ^{cd}	4.9 ^{d}	5.4 ^{b}	5.4 ^{b}	5.2 ^{bc}	5.7 ^{a}
Q2.22	***	4.4 ^{bc}	4.6 ^{b}	5.3 ^{a}	5.1 ^{a}	4.2 ^{c}	5.1 ^{a}
Price and purchase intention							
Q2.3	***	4.9 ^{c}	5.2 ^{ab}	5.0 ^{bc}	5.3 ^{a}	5.3 ^{a}	5.0 ^{bc}
Q2.10	***	4.7 ^{cd}	4.5 ^{d}	5.0 ^{b}	4.8 ^{bc}	4.9 ^{bc}	5.3 ^{a}
Q2.15	***	4.3 ^{b}	4.3 ^{b}	4.5 ^{b}	5.2 ^{a}	5.0 ^{a}	5.3 ^{a}
Q2.17	***	5.2 ^{d}	5.6 ^{abc}	5.7 ^{ab}	5.5 ^{cd}	5.5 ^{bc}	5.8 ^{a}
Q2.27	***	4.3 ^{c}	5.4 ^{a}	5.1 ^{b}	5.1 ^{b}	5.0 ^{b}	5.4 ^{a}
Q2.30	***	4.0 ^{d}	4.9 ^{b}	4.8 ^{bc}	4.8 ^{bc}	4.7 ^{c}	5.5 ^{a}
Health effect							
Q2.6	***	4.3 ^{a}	3.8 ^{c}	4.0 ^{bc}	3.5 ^{d}	3.9 ^{bc}	4.1 ^{ab}
Q2.9	***	3.7 ^{bc}	3.8 ^{bc}	3.7 ^{c}	4.0 ^{b}	4.4 ^{a}	4.3 ^{a}
Q2.18	***	4.5 ^{bc}	4.3 ^{d}	4.7 ^{ab}	4.5 ^{bcd}	4.4 ^{cd}	4.8 ^{a}
Q2.21	***	5.1 ^{c}	4.8 ^{d}	5.8 ^{ab}	5.9 ^{a}	5.6 ^{b}	5.9 ^{a}
Relevance to consumers							
Q2.4	***	5.5 ^{c}	5.7 ^{bc}	6.0 ^{a}	5.7 ^{b}	5.8 ^{ab}	5.9 ^{ab}
Q2.7	***	4.3 ^{c}	4.3 ^{c}	5.1 ^{a}	4.9 ^{ab}	4.9 ^{ab}	4.8 ^{b}
Q2.16	***	4.4 ^{c}	5.4 ^{ab}	5.6 ^{a}	5.6 ^{a}	5.3 ^{b}	5.7 ^{a}
Q2.17	***	5.4 ^{c}	5.9 ^{a}	6.0 ^{a}	5.8 ^{a}	5.8 ^{a}	5.6 ^{b}
Q2.23	***	5.3 ^{b}	5.3 ^{b}	5.6 ^{a}	5.4 ^{ab}	5.4 ^{ab}	5.4 ^{ab}

[†] **** significant at $p < 0.001$.* [‡]*Values followed by different letters for the same question were significantly different ($p < 0.05$).*

intensive agriculture to maintain world food production (Q2.29; 5.3), whereas more developed countries, such as the United States and Spain, evaluated these aspects with lower scores (4.6 and 4.8, respectively). On the other hand, these countries tend to pay less attention to food labeling (Q2.13), especially USA (4.4) whereas consumers in India and China pay more attention to the ingredient list of the food they eat (5.6 and 5.5, respectively). Also, Chinese consumers were those who gave the lowest scores regarding the affirmation "the less food packaging, the more sustainable the food" (Q2.11; 3.9).

Regarding the water use in agriculture, China and Spain were less in agreement with the statement "the volume of water needed to grow 1 lb of tomatoes is approximately the same as the amount needed to grow 1 lb of wheat" (Q2.28; 3.6 for both countries) (Table 2).

Considering age and education, in general, it could be said that consumers aged between 24 and 52 (millennials, generation X) and those having a higher level of education agreed with the basic knowledge statements. Consumers with the highest income agreed more with the statements, except for the one related to animal welfare, in which they gave the lowest score (Tables 3-4). The factor gender rendered no significant differences in all categories of questions (Table 3-4).

Benefits for local communities. In general, Mexican consumers showed higher respect for valuing local sustainable activities of small and local farmers. On the other hand, US consumers showed the lowest scores, with the exception of the affirmation "small farmers are essential to guarantee farming sustainability in the world (Q2.24)", in which China had the lowest score (5.2) (Table 2).

In general, consumers included in the lowest age range disagreed the most with the benefit provided by small farmers and the reduction of food transport in sustainability. With respect to income and education, those consumers with the highest income and the highest education provided the highest scores for such statements (Tables 3-4).

Sensory quality. The third category of questions "sensory quality", refers to those sensory issues that are influenced by sustainability. In general, worldwide consumers associated organic foods with products of higher quality including appearance attributes.

Most of the consumers worldwide agreed with the statement "food produced locally is fresher than those sold in supermarkets or hypermarkets (Q2.19)" while the level of agreement significantly decreased for Q2.14 about rain-fed products (Table 2). Spanish and US consumers gave lower scores to the Q2.22 statement "organic vegetables have a nice appearance and are uniform".

Price and purchase intention. In general, consumers express their desire to buy food from local or nearby markets or producers (Table 2).

Certainly, Indian consumers were the most prone to pay and agree with the statement that the sustainable (local and organic) products are worth the price increase; while, US consumers were on the least likely to agree with that statement (Table 2).

Generally, it was observed that consumers between 24 and 52 years old (millennials and gen X) showed greater willingness to pay, as so did consumers whose level of studies was graduate degree or higher. On the other hand, consumers who made 25,000 US dollars or less were much less likely to show purchase intention than those who made more, as every dollar counts and, buying sustainable products was viewed as a luxury option (Table 3-4).

Health effects. The health statements under study included, nutrients, antioxidants content, fatty acids profile, and assimilation by the

Table 3
Consumers opinion on sustainability issues as affected by the "age" and "gender" factors.

Question	ANOVA[†]	Age				ANOVA[†]	Gender	
		18–23	24–41	42–52	53–73		Male	Female
Basic statements								
Q2.1	***	4.6 [b, ‡]	4.8 [a]	4.8 [a]	4.5 [b]	NS	4.6	4.7
Q2.2	***	5.3 [b]	5.5 [a]	5.5 [a]	5.3 [ab]	NS	5.3	5.5
Q2.5	***	4.4 [b]	4.6 [a]	4.5 [ab]	4.5 [ab]	NS	4.5	4.5
Q2.11	***	4.6 [c]	4.9 [ab]	5.1 [a]	4.9 [b]	NS	4.8	5.0
Q2.13	***	5.0 [b]	5.2 [a]	5.1 [ab]	5.0 [b]	NS	5.0	5.1
Q2.28	***	3.7 [b]	3.8 [b]	4.0 [a]	3.8 [b]	NS	3.7	3.9
Q2.29	***	4.7 [b]	4.8 [ab]	5.0 [a]	5.0 [a]	NS	4.9	4.8
Benefits for local communities								
Q2.8	***	5.6 [b]	5.9 [a]	5.8 [a]	5.6 [b]	NS	5.7	5.7
Q2.24	***	5.5 [b]	5.9 [a]	5.9 [a]	5.7 [a]	NS	5.7	5.8
Q2.25	***	5.4 [b]	5.7 [a]	5.7 [a]	5.6 [ab]	NS	5.5	5.6
Q2.26	***	5.6 [b]	5.8 [a]	5.9 [a]	5.8 [a]	NS	5.8	5.8
Q2.31	***	5.4 [b]	5.7 [a]	5.8 [a]	5.7 [a]	NS	5.7	5.7
Sensory quality								
Q2.14	***	4.3 [c]	4.6 [ab]	4.7 [a]	4.4 [bc]	NS	4.4	4.6
Q2.19	***	5.5 [b]	5.7 [a]	5.7 [ab]	5.5 [b]	NS	5.6	5.7
Q2.20	***	5.1 [b]	5.4 [a]	5.4 [a]	5.3 [ab]	NS	5.2	5.4
Q2.22	***	4.8 [ab]	4.9 [a]	4.8 [ab]	4.6 [b]	NS	4.8	4.8
Price and purchase intention								
Q2.3	***	5.0 [b]	5.2 [ab]	5.3 [a]	5.0 [b]	NS	5.0	5.2
Q2.10	***	4.7 [c]	4.9 [ab]	5.0 [a]	4.8 [bc]	NS	4.8	4.9
Q2.15	***	4.6 [c]	4.8 [ab]	4.9 [a]	4.7 [bc]	NS	4.6	4.9
Q2.17	***	5.4 [b]	5.6 [a]	5.6 [a]	5.5 [ab]	NS	5.5	5.6
Q2.27	***	5.0 [b]	5.3 [a]	5.1 [b]	4.7 [c]	NS	5.0	5.0
Q2.30	***	4.7 [b]	5.0 [a]	4.9 [a]	4.5 [b]	NS	4.8	4.8
Health effect								
Q2.6	***	3.7 [c]	3.9 [b]	4.1 [ab]	4.1 [a]	NS	4.0	3.9
Q2.9	***	3.9 [b]	3.9 [b]	4.2 [a]	4.0 [ab]	NS	3.9	4.0
Q2.18	NS	4.6	4.6	4.6	4.4	NS	4.5	4.6
Q2.21	NS	5.4	5.6	5.6	5.4	NS	5.4	5.6
Relevance to consumers								
Q2.4	***	5.5 [b]	5.8 [a]	5.9 [a]	5.8 [a]	NS	5.7	5.8
Q2.7	NS	4.8	4.7	4.8	4.6	NS	4.7	4.8
Q2.16	NS	5.3	5.4	5.4	5.2	NS	5.3	5.3
Q2.17	NS	5.7	5.8	5.8	5.7	NS	5.7	5.8
Q2.23	***	5.2 [c]	5.4 [ab]	5.6 [a]	5.3 [bc]	NS	5.4	5.4

[†] *NS, not significant (p greater than 0.05) and *** significant at $p < 0.001$.* [‡]*Values followed by different letters, for the same question and the same factor, were significantly different ($p < 0.05$). Age: 18–23 years old (Centennials); 24–41 years old (Millennials); 42–52 years old (Gen X) and 53–73 years old (Baby Boomers).*

body, etc. In general, results showed that Chinese consumers provided the lowest scores for most of the questions; US consumers had a similar tendency except for the antioxidant content of organic fruits in which they gave the highest score (Table 2). On the other hand, India had the highest scores in all questions, especially in those which are certainly true such as Q2.21 (5.9), indicating that Indian consumers are preoccupied by healthy issues.

Consumers in the range 18–23 years old gave the lowest scores for the health effects questions, whereas consumers with a graduate degree or higher gave the highest ones. Regarding income, consumers with incomes above 50,000 US dollars agreed that nutrients and bioactive compounds contents are different in conventional and organic fruit (Table 3-4).

Relevance to consumers. The last category of questions "relevance to consumers" sought to establish the relevance and impact that sustainability has on current society. In this category, US consumers gave the lowest scores for all questions, closely followed by Chinese consumers. On the other hand, Mexico showed the highest scores indicating the high relevance that sustainability has for its population; besides, in most of the cases, Brazil, Spain and India had a similar trend to Mexico.

Consuming seasonal vegetables (Q2.4) was perceived as possibly one of the easiest ways of being sustainable (Table 2); worldwide consumers agreed with this statement and the global mean for the whole study rendered a value of 5.8 (~agree), which is one of the highest mean values. We also found that consumers are willing to buy sustainable products, if the price is not too high and they are able to buy them without jeopardizing their budget (Q2.17).

Younger consumers were less in agreement with the questions relative to the category "relevance to consumers". Consumers with the highest income and education level were more agreement with the questions relative to the category "relevance to consumers".

To complement the results, a PCA was performed. Overall, consumers in each country vary in their responses to questions related to perception of sustainability. Consumers in India, Mexico, and Brazil show a higher belief in some questions related to use of seasonal products (Q2.5), environmental and packaging (Q2.8, Q2.12), health and safety concerns (Q2.13, Q2.23) and economic (Q2.9) impacts on sustainability than do either China or the USA, with Spain somewhere in the middle. In contrast, China shows higher belief that sensory and quality issues intersect with sustainability issues (Q2.6, Q2.15), environmental (Q2.2, Q2.14, Q2.17), and price (Q2.29, Q2.32) impacts and less interest in animal welfare (Q2.3) as associated with sustainability than did any of the other countries, with the USA the most different in those aspects (Fig. 1).

Females were much more likely to be focused on animal welfare (Q2.3), seasonal consumption (Q2.5), price (Q2.18), societal fairness (Q2.27), and believed knowledge that was not necessarily correct about sustainability issues (Q2.30) than men. The small percentage of the population who did not provide a gender fell in the middle on that dimension (Factor 2) which suggests they were made up of both men and women. However, that unknown group clearly was different on Factor 1 than men or women, who were similar for that factor. However, Factor 1 had had many questions that had some marginal impact on the factor (≤4% for any individual question), with none having any major impact

Table 4
Consumers opinion on sustainability issues as affected by the "income" and "education" factors.

Question	ANOVA†	Income				ANOVA†	Education				
		≤25.000	25.001–50.000	50.001–100.000	greater than100.000		≤Primary school	High school	Associate's degree	Bachelor's degree	≥Graduate degree
Basic statements											
Q2.1	***	4.4 c, ‡	4.7 b	4.8 b	5.2 a	***	4.2 c	4.4 bc	4.5 bc	5.0 a	4.6 ab
Q2.2	***	5.6 a	5.6 a	5.2 b	4.9 c	***	5.3 bc	5.4 bc	5.5 ab	5.0 c	5.8 a
Q2.5	***	4.4 b	4.6 b	4.4 b	4.8 a	***	4.4 abc	4.3 c	4.3 bc	4.7 a	4.5 ab
Q2.11	NS	4.9	5.0	4.9	4.8	***	4.6 b	4.7 b	5.1 a	4.7 b	5.2 a
Q2.13	***	4.9 b	5.1 b	5.1 ab	5.4 a	***	4.5 b	4.8 b	4.8 b	5.2 a	5.3 a
Q2.28	NS	3.7	3.9	3.8	3.8	NS	3.7	3.8	3.7	3.8	3.9
Q2.29	***	4.8 ab	4.9 ab	4.8 b	5.1 a	***	4.4 b	4.7 b	4.8 ab	4.9 a	5.0 a
Benefits for local communities											
Q2.8	***	5.8 ab	5.7 b	5.7 b	5.9 a	***	5.2 d	5.5 cd	5.6 bc	5.8 ab	5.9 a
Q2.24	***	5.9 a	5.8 ab	5.6 c	5.6 bc	***	5.5 b	5.6 b	5.8 b	5.6 b	6.0 a
Q2.25	NS	5.6	5.6	5.5	5.7	***	5.3 b	5.4 b	5.5 b	5.6 b	5.8 a
Q2.26	***	5.7 b	5.8 ab	5.8 ab	6.0 a	***	5.4 c	5.6 bc	5.7 ab	5.8 ab	5.9 a
Q2.31	***	5.7 b	5.7 ab	5.6 b	5.9 a	***	5.3 b	5.6 b	5.5 b	5.7 ab	5.8 a
Sensory quality											
Q2.14	NS	4.5	4.6	4.4	4.6	NS	4.3	4.4	4.4	4.5	4.6
Q2.19	***	5.7 a	5.7 a	5.5 b	5.5 b	***	5.3 b	5.5 ab	5.6 ab	5.5 ab	5.8 a
Q2.20	NS	5.3	5.4	5.2	5.3	NS	4.9	5.2	5.2	5.3	5.4
Q2.22	***	4.9 a	4.8 a	4.6 b	4.8 ab	NS	5.1	4.8	4.7	4.8	4.8
Price and purchase intention											
Q2.3	***	5.0 b	5.2 a	5.1 ab	5.3 a	NS	4.9	5.0	5.1	5.2	5.2
Q2.10	***	4.7 b	4.9 a	4.9 a	5.1 a	***	4.3 c	4.7 bc	4.7 bc	4.8 b	5.1 a
Q2.15	***	4.6 b	4.8 a	4.8 a	4.9 a	***	4.4 b	4.7 b	4.6 b	4.7 b	5.0 a
Q2.17	***	5.5 ab	5.6 ab	5.4 b	5.7 a	***	4.9 d	5.4 cd	5.5 bc	5.6 ab	5.7 a
Q2.27	***	4.9 c	5.0 bc	5.1 b	5.4 a	***	4.6 b	4.7 b	4.8 b	5.2 a	5.2 a
Q2.30	***	4.6 b	4.8 b	4.8 b	5.2 a	***	3.9 c	4.4 bc	4.6 b	5.0 a	5.0 a
Health effect											
Q2.6	***	3.8 b	4.1 a	4.0 ab	4.0 ab	***	3.3 c	3.8 bc	3.9 abc	4.0 ab	4.1 a
Q2.9	***	3.8 b	4.1 a	4.1 a	4.1 a	NS	4.1	3.8	4.0	4.0	4.1
Q2.18	NS	4.5	4.6	4.5	4.6	***	4.6 ab	4.4 b	4.5 ab	4.5 ab	4.7 a
Q2.21	***	5.6 a	5.6 a	5.3 b	5.5 ab	***	5.6 ab	5.4 b	5.4 b	5.4 b	5.7 a
Relevance to consumers											
Q2.4	NS	5.8	5.8	5.7	5.9	***	5.3 b	5.6 b	5.8 a	5.8 a	5.9 a
Q2.7	NS	4.7	4.8	4.7	4.7	***	4.5 b	4.6 b	4.7 ab	4.7 ab	5.0 a
Q2.16	NS	5.3	5.3	5.3	5.4	***	5.0 bc	5.0 c	5.2 bc	5.4 b	5.6 a
Q2.17	***	5.7 b	5.8 b	5.7 b	6.0 a	***	5.1 c	5.6 b	5.6 b	5.8 a	5.9 a
Q2.23	***	5.4 ab	5.4 ab	5.3 b	5.6 a	***	5.1 b	5.3 ab	5.3 ab	5.4 ab	5.5 a

† *NS, not significant (p greater than 0.05) and *** significant at p < 0.001.* ‡*Values followed by different letters, for the same question and the same factor, were significantly different (p < 0.05). Income: ≤25.000 US dollars, 25.001–50.000 US dollars, 50.001–100.000 US dollars and greater than 100.000 US dollars. Level education: primary school or less, high school diploma, associate's degree, bachelor's degree and graduate degree or higher.*

on the dimension. We speculate that some variable other than gender that co-varies with the need to remain demographically anonymous may have impacted this dimension (Fig. 2).

The principal components analysis clearly differentiated among the age groups (Fig. 3) with one age group in each of the quadrants. Animal welfare (Q2.3), economic aspects (Q2.9), price (Q2.11, Q2.18), health (Q2.13), sensory (Q2.15), buying local (Q2,16), nutrition (Q2.21), safety (Q2.23), environment (Q2.25), maintenance of small farms (Q2.26), and societal fairness (Q2.27) tended to score higher for millennials (age 24–41) and gen X (age 42–52) respondents than for either the oldest group, baby boomers (age 53–73), or the youngest group, centennials (age 18–23). In contrast, the oldest of the groups studied, baby boomers and gen X, were more likely than younger consumers to place a key emphasis on nutrition (Q2.7, Q2.19), price (Q2.11, Q2.29), economics (Q2.28), buying local (Q2.33), and that intensive agriculture would still be needed (Q2.31). It should be noted that some of these issues, such as economic aspects, nutrition, and buying local overlap among all of the older groups, which means that the youngest group has a different focus either because of their stage in life where other issues simply are more important, which simply means their focus may change over time, or as a lasting group effect of disinterest based perhaps on what they may perceive as an overemphasis on those issues among the larger society. Either way this was a surprising finding given that younger consumers often are seen as being at the forefront of sustainability issues.

Education had a definite impact on consumers' association of various statements regarding sustainability. The largest impact can be noted for Factor 1, which shows that as education increased from primary school to a graduate degree, consumers' beliefs about the economic benefits of sustainability (Q2.9, Q2.28), eating seasonally, willingness to pay (Q2.4, Q2.11, Q2.18, Q2.32), health aspects (Q2.13), identification with labeling (Q2.14), buying local (Q2.16, Q2.33), environmental concerns (Q2.25) and the continued need for intensive agriculture increased. In contrast, the lowest and highest levels of education differentiated from other educational levels on Factor 2 that emphasized animal welfare (Q2.3), nutrition (Q2.10, Q2.19), safety (Q2.23), and sensory (Q2.14) aspects and was slightly negatively impacted by environment (Q2.2). This clearly shows that education plays a part in people's interest and their specific concerns related to sustainability (Fig. 4). Usually, higher education means higher income, and therefore are more likely to show greater environmental concern. People who grow up under a prosperous income level generally are more concerned about environmental problems (Klöckner, 2013).

For consumers, the main characteristics (marked by ≥30% of the consumers worldwide) of a sustainable product are (Fig. 5): (1) I recommended their purchase to my family/friends; (2) there are environmental friendly; (3) there is a need for a logo that clearly identifies them; (4) they are authentic because they ensure a proper future of agriculture; (5) they are healthier; (6) they are more expensive; (7) they are produced in a more traditional way; (8) they are grown or produced with

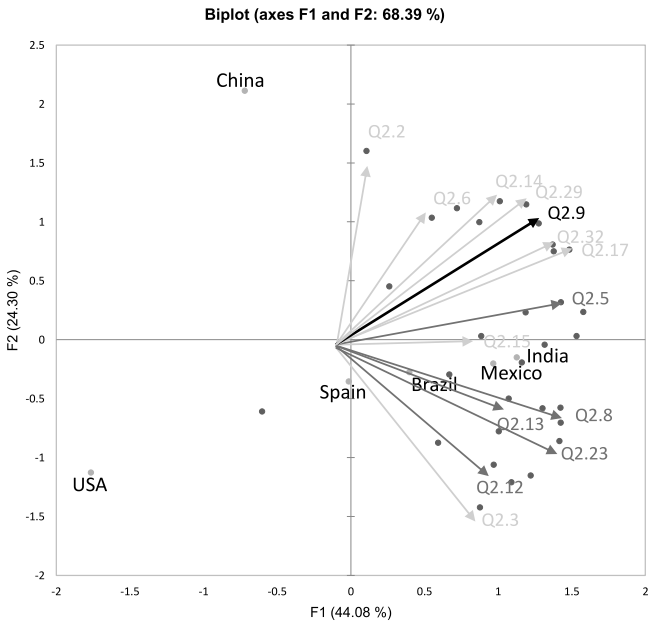

Fig. 1. PCA bi-plot of country and questions related to beliefs about sustainability. Legend: Soft grey color denotes questions Loading Heavily on Factor 1; Dark grey color denotes questions Loading Heavily on Factor 2; Black color denotes question Loading Heavily on Both Factor 1 and 2; Points without a line do not load heavily on either Factor 1 or 2.

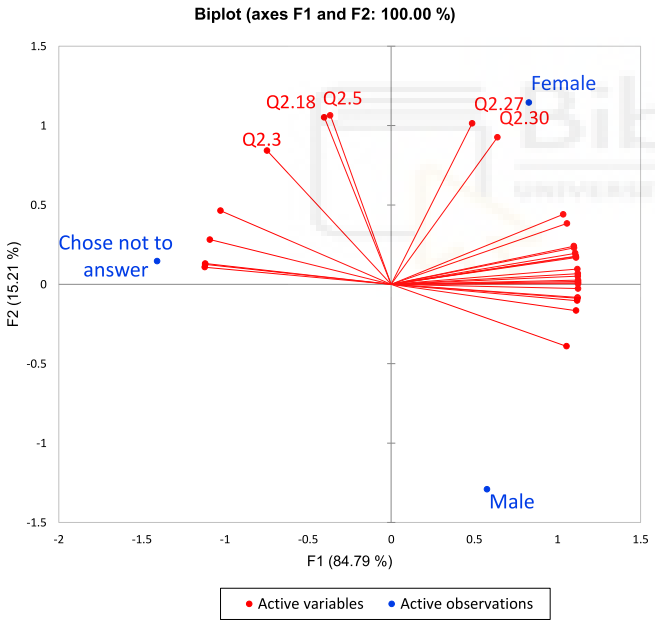

Fig. 2. PCA bi-plot of gender and questions related to beliefs about sustainability.

fewer chemicals; (9) they are tastier; (10) they increase my trust; (11) they have better quality; and, (12) they look natural.

Understanding how sustainable products are perceived by consumers in each of country is a key issue. Results showed that consumers from each country have different ways of explaining what properties a sustainable product has or the way they are grown and produced. Most of the consumers agree in the fact that they are "environmental friendly" and, most think, they are "healthier", use "few chemicals" in their production and "have better quality". Many of these terms are also frequently associated with organic production (Boobalan & Nachimuthu, 2020; Popa et al., 2019).

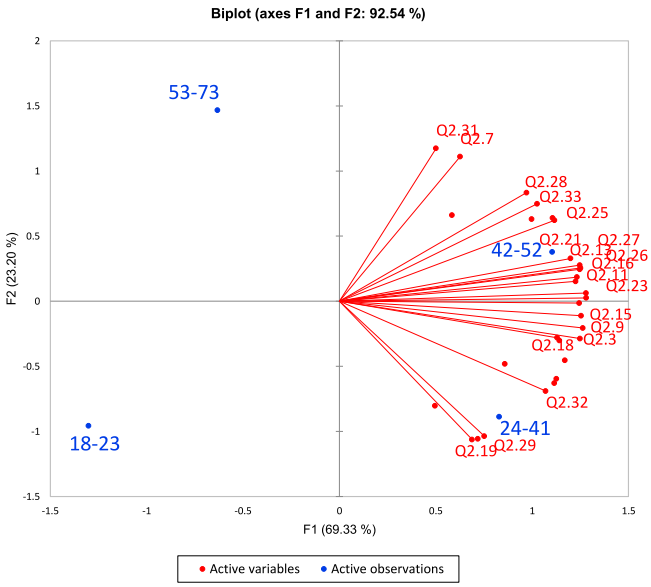

Fig. 3. PCA bi-plot of age and questions related to beliefs about sustainability.

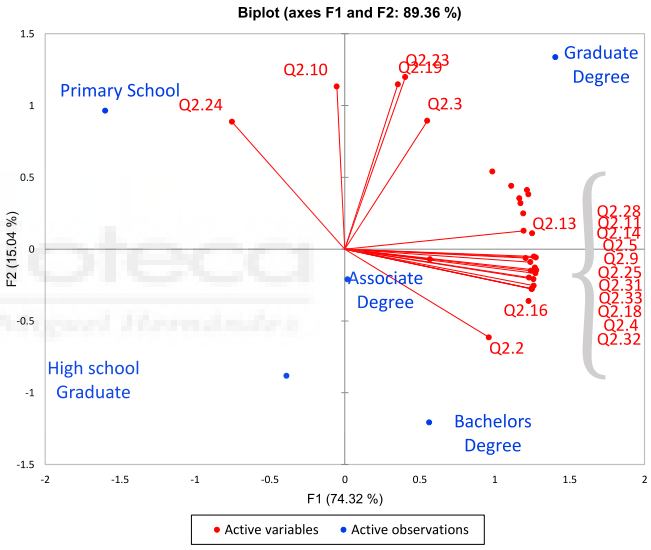

Fig. 4. PCA bi-plot of education and questions related to beliefs about sustainability.

	USA	China	Mexico	Brazil	Spain	India
I recommend them				■		
Environmental Friendly	■	■	■	■		■
Need for logo		■			■	
Authentic		■				
Healthier	■	■	■	■	■	
More expensive	■			■		
Traditional production			■		■	
Few chemicals	■		■		■	
Tastier				■	■	
Increase my trust					■	
Better quality			■	■	■	■
Look natural		■		■		■

Fig. 5. Statements that a sustainable product must have (marked by ≥ 30% of for each country USA, China, Mexico, Brazil, Spain and India).

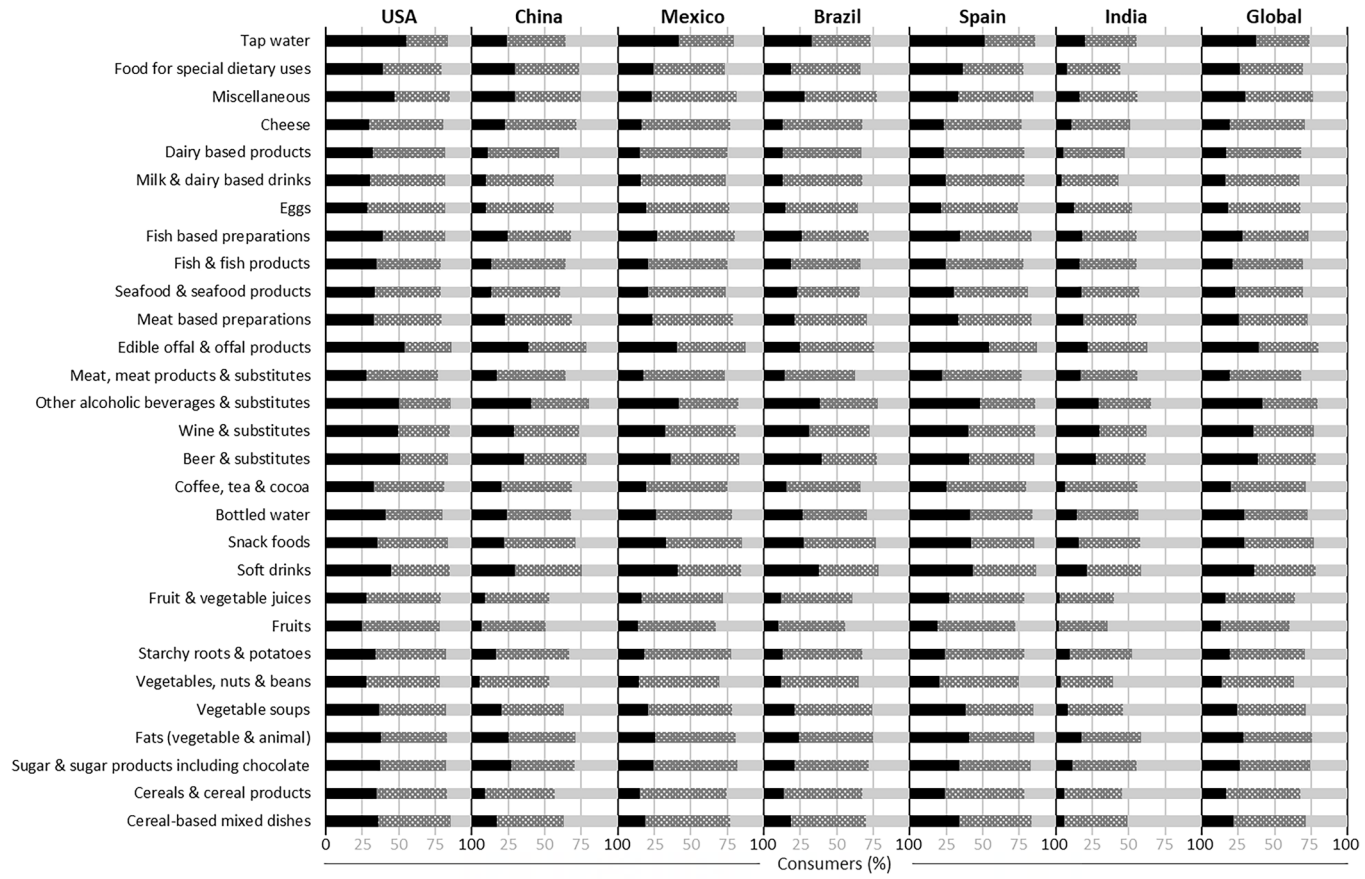

Fig. 6. Percentages of willingness to pay (0% , at least 5% , at least 20%) for each more sustainable food categories, assuming products at the same liking as your current products for each country (USA, China, Mexico, Brazil, Spain and India).

Regarding "willingness to pay" more for sustainable products (Fig. 6), in a general way, it was found that more than 30% of US and Spain consumers were not willing to pay more for sustainable products. The percentage of people unwilling to pay anything more was reduced to 20% in the case of China, Mexico and Brazil and reached even lower in the case of India (~14%).

More than 30% of US consumers were "not" willing to pay a higher price for 23 out of 29 groups of food products, including for instance cereal-based mixed dishes, vegetable soup, soft drinks, snack foods, bottled water, coffee, tea and cocoa, beer and substitutes, wine and substitutes, … and tap water. However, more than 60% of US consumers were willing to pay at least 5% more for all products except soft drinks, bottled and tap water, beer, wine and alcoholic beverages, edible offal and offal products and miscellaneous food products. A relevant finding regarding US consumers is that <20% were willing to pay at least 20% more for vegetables, nuts and beans, fruits, fruit and vegetable juices, meat, meat products and substitutes, meat based preparations, seafood and seafood products, fish and fish products and food for special dietary uses (Fig. 6).

In contrast with US consumers, more than 60% and 70% of consumers in China and India, respectively, were willing to pay more than 5% for all food categories, and among them, at least 20% would also pay 20% more for all categories. Only about 30% of consumers would "not" pay a higher price for beer and substitutes or other alcoholic beverages, edible offal and offal products, miscellaneous and food for special dietary uses for China and wine and substitutes or other alcoholic beverages in the case of India (Fig. 6).

Mexico and Brazil had a similar behavior in their willingness to pay. At least 30% of Mexican consumers were not willing to pay a higher price for soft drinks, snack foods, beer, wine and substitutes and other alcoholic beverages, edible offal and offal products and tap water around 30% of Brazilian consumers for soft drinks, beer, wine and substitutes and other alcoholic beverages and tap water; whereas more than 60% of Mexican consumers were willing to pay >5% for all categories, except the tap water. Among them, >20% of Brazilian consumers were willing to pay at least 20% more for all categories. In contrast, 20% of Mexican consumers were not willing to pay that increase for the following products: soft drinks, snack foods, beer, wine and substitutes and other alcoholic beverages, edible offal and offal products and miscellaneous (Fig. 6).

Finally, more than 30% of Spanish consumers were not willing to pay a higher price for 17 of the food categories studied, including cereal-based mixed dishes, sugar and sugar products, fats, vegetables soups, soft drinks, snack foods, bottled and tap water, etc. On the other hand, more than 60% of them were willing to pay at least 5% more for all products except soft drinks, snack foods, other alcoholic beverages, edible offal and offal products and tap water. Finally, only 20% of them were willing to pay more than 20% for cereals and cereal products, vegetables, nuts and beans, starchy roots and potatoes, fruits, fruit and vegetable juices, coffee, tea and cocoa, meat, meat products and substitutes, fish and fish products, eggs, milk and dairy based drinks, dairy based products, cheese and food for special dietary uses (Fig. 6).

4. Discussion

Results showed small numerical differences which become 'significant' because of the number of observations. It can be said that that although the difference may seem small, it still accounts for nearly 5% of the total scale value, and a much greater percentage of the range of percentages, or the standard deviation of those percentages. In perceptual scaling the differences often seem small because consumers often do ɔt use the ends of the scale, which reduces the number of points used

and forces the means towards the middle.

Related to the category "basic statements or definitions" it can be highlighted that, in general, consumers are not fully aware of the amount of water consumed by a crop or the level of importance that an automation of crop irrigation may have in the quality of the products.

Chinese consumers were more committed to a vegetarian diet as a possible way to reduce greenhouse gases than other countries, and who presented the lowest concerns about animal welfare. This may be due to the fact that in China meat consumption is increasing but without a deep knowledge on animal welfare issues, whereas for instance in Europe has been implementing welfare regulations in the recent years (OECD-FAO, 2018).

It is also understandable that both Indian and Chinese consumers, prefer conventional and highly automated agriculture given that those are highly populated countries, intensive and automated agriculture leads to greater production and, therefore, allows access to foods for a higher percentage of the population (Masaquiza Moposita, Pereda Mouso, Curbelo Rodríguez, Figueredo Calvo, & Cervantes Mena, 2017). However, intensive agriculture will not produce enough in the future to supply the entire world population, in part because of transportation and distribution issues. Thus, more efficient, environmentally friendly and socially equitable farming systems will be necessary (de Schutter, 2010; IAASTD, 2009). In this sense, agroecological systems become key to the sustainable future, since they promote biodiversity, are energy efficient, may be socially fair, tend to transform industrial agriculture towards local/traditional production (driven by small farmers) and ensure the food sovereignty (Altieri, Funes-Monzote, & Petersen, 2012). Food sovereignty is defined as the right of the entire population to access safe, nutritious and culturally appropriate food, with sufficient quality and quantity to lead a healthy life (Altieri et al., 2012; Shattuck & Holt-Giménez, 2010).

Furthermore, China and India consumers pay more attention to labeling. This could be correlated to food fraud episodes in food industries, for example the case of faked eggs in China (Boehler, 2012).

Regarding the water use un agriculture, China and Spain presented the lowest values, which suggests that these consumers have a greater knowledge of the needs of different crops because they are countries where cereals and tomatoes are important crops contributing to their economy (FAOSTAT, 2020). However, means from all countries are close to the mid-point of the scale, which is reasonable because it is a technical question, which few consumers may know the answer to.

In general, younger generations and consumers with higher education level were more in agreement with the basic statement. This is because the level of education is key to consumer behavior; a higher level of education is associated with a greater concern for environmental problems and sustainability (Mancini, Marchini, & Simeone, 2017). This happen similarly in the Millennial generation, who are more concerned with sustainability and environmental issues (Bollani, Bonadonna, & Peira, 2019).

Questions on "relative benefits for local communities" include those aspects of sustainability that generate benefits for small farmers, such as the size of the farms, gastronomic tourism, fair trade, water footprint, which is an indicator of freshwater of a consumer or producer (Vanham, Hoekstra, & Bidoglio, 2013), or km 0 concept, that is a branding initiative to promote local sourcing and consists of acquiring and fostering the purchase and production of products whose origin is <100 km from the distribution point (FAO, 2020). This concept is also link to how consumers around the world value the effect of sustainability in their communities. In this sense, US consumers presented the lowest scores with the exception of questions Q2.24, in which China showed the lowest value. The question is related to the importance of small farmers to ensure sustainability. This results must be due to the belief of Chinese consumers that intensive agriculture is necessary to maintain world production, due to the overpopulation that this country presents. On the other hand, FAO reports that it is likely that meeting the growing demands of agriculture with existing agricultural practices will lead to more intense competition for natural resources, an increase in greenhouse gas emissions and greater deforestation and land degradation (FAO, 2017); all these effects are fully non-sustainable. Consequently, looking for alternatives (such as agro-tourism, supporting local foods, etc.) is increasingly necessary. In China, some studies showed the relationship between the need to increase food production and the consequent stress generated in the environment; the recommendations to avoid this situation were, among others, reducing food losses, eliminating unsustainable practices on groundwater, controlling over-fertilizer application (McLaughlin & Kinzelbach, 2015).

The lowest age range was also disagreed with the role of small farmers, and, with the reduction of food transport too; it seems that young generations are still not aware of the importance of these sustainable strategies or they do not care at this stage of their lives.

Taking a view on "sensory quality", in general, worldwide consumers thought that organic food have higher quality, although this has not been supported by scientific data (Prentice, Chen, & Wang, 2019) (Q2.22). However, in a recent study it was shown that consumers of organic products base their choice mainly on environmental issues (Ditlevsen, Denver, Christensen, & Lassen, 2020). In this sense, Spain and US consumers gave the lowest scores regarding to the "nice appearance" of organic food, perhaps because those consumers are among the most used to this type of products, which, in general, have less appealing appearance than the conventional ones (Prentice et al., 2019).

Lately, local and organic food is receiving more attention in consumer research (Ditlevsen et al., 2020) and large marketing campaigns have been conducted all over the world. Thus, the results obtained in the current study are not surprising. This data is considered of great importance, since local products generate a significantly lower water footprint (Hoekstra, Chapagain, Aldaya, & Mekonnen, 2011), and therefore could be considered more sustainable than those imported from other countries. However, it has been shown that Danish consumers of local products do not base their choice on environmental opinions or values (Ditlevsen et al., 2020) but on taste, authenticity, diversity and, especially, local production. In this sense, Indian consumers were the most prone to pay for sustainable products, whereas US consumers were the least. This could be due to the fact that India is a country with development prospects, its consumers are more aware of climate change, the starting prices of products are lower than in other countries, or there is high concern for non-organic and imported products. In addition, it may be that because the survey was done online, the poorest people did not have access to the questionnaire although that is not consistent with data showing high internet access in the countries chosen (Roser, Ritchie, & Ortiz-Ospina, 2015). Besides, were the lower income those who were less willing to pay a greater amount of money for this type of product. This showed that income is an important factor when it comes to buying sustainable products (Yin, Wu, Du, & Chen, 2010; Yu, Gao, & Zeng, 2014).

Looking at "health effects" statement, in general, India had the highest scores in all questions. This is mainly because Indian consumers have the belief that organic foods provide more health benefits than conventional food, but in more developed countries, such as US, consumers prefer conventional foods, due to their perception that the taste of organic foods is not so good as compared to conventional foods (Boobalan & Nachimuthu, 2020; Dubé, Fatemi, Lu, & Hertzer, 2016; Feldmann & Hamm, 2015; Ramesh, Singh, & Rao, 2005).

Besides, worldwide consumers thought that organic foods must have higher contents of beneficial compounds for health and also have no chemical compounds, such as pesticides. It is essential to remember that organic production is a general system of agricultural management and food production that combines the various environmental practices, a high level of biodiversity, the preservation of natural resources, the application of demanding standards on animal welfare and a production according to preferences of certain consumers for products obtained om natural substances and processes; (R834/2007). Several non-

synthetic pesticides (e. g. sulphur, copper sulphate, potassium permanganate, etc.) and fertilizers are allowed in organic farming (R889/2008; Popa, Mitelut, Popa, Stan, & Popa, 2019). Some authors claim that the consumer decision to buy organic food is based mainly on beliefs related to its health benefits rather than on its environmental benefits (Boobalan & Nachimuthu, 2020; Prentice et al., 2019). Today, consumers with low urban wages tend to spend their money on convenience food items, including fast food, store-bought prepared foods, and food prepared and marketed by street vendors. As a consequence, the nutrient content of diets is changing. In general, diets are increasingly high in salt, fat and sugar and, in general, are more energy dense. This change in consumption patterns also means a change in employment within the food system: fewer people work in agriculture and more in transport, wholesale, retail, food processing and sales (Cohen & Garrett, 2010; FAO, 2017), which is certainly less sustainable.

Regarding to willingness to pay, in general, there was a similar trend among the more developed countries (Spain and USA), while India was the country with the highest willingness to pay. Sustainable products are, in general, more expensive; thus, consumer willingness to pay is essential for their success. Unfortunately, the United States Department of Agriculture suggests that the vast majority of organic product sold in the USA has a price premium well above 25% higher than conventionally produced products (Carlson & Jaenicke, 2016). Also, A recent online price comparison of a "market basket" of foods suggested that prices were 35–40% higher overall for organic products (eSvasa, n.d.). In China data suggests that the price differential is much higher ranging from 200 to 1000% higher for organic products compared to conventional products (Lagos, Scott, Rasmussen, Bugang, & Chen, 2010). On the other hand, organic product use in Brazil is low because of the high cost differential vs conventional products followed by limited and irregular access and availability issues (Martins et al., 2020).

On the other hand, the certification of the products may be another determining factor when determining their purchase (Prentice et al., 2019). For example, in the case of organic products, Indian consumers were more likely to accept and buy such products, due to their belief that they are more beneficial and healthy; however, their consumption or integration into the Indian market was complicated because organic food producers did not follow certification systems. In contrast, US consumers fully rely on compliance with the standards set by the certification agency of the USDA (The United States Department of Agriculture), making their sales easier and safer; however, even with these advantages, US consumers still prefer conventional foods because they believe that its flavor is more intense (Dubé et al., 2016; Feldmann & Hamm, 2015).

5. Conclusions

In general, consumers associate sustainable production with organic products, and in turn, associate organic products with higher quality and health benefits. Consumers from USA and Spain were more reticent to pay an increase in price for sustainable products; on the other hand, more consumers from India were willing to invest more money for these specific types of foods. Consumers in China, Mexico and Brazil reported a more moderate behavior pattern between the most developed countries (USA and Spain) and India. It must be noted that in surveys, respondents tend to overexpress their willingness to pay, which may not necessarily be reflected in their actual behavior. This was noted in the percentage of Brazilian respondents who stated they were willing to pay more for organic products when actual consumption is quite low. Consumers with a higher level of education showed a greater concern for sustainability and the environment and were willing to pay a higher price for sustainable products. The same trend was true for millennials, who showed greater concern for the environment and, along with gen X, a greater willingness to pay for sustainable products.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Altieri, M. A., Funes-Monzote, F. R., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty. *Agronomy for Sustainable Devlopment, 32*(1), 1–13. https://doi.org/10.1007/s13593-011-0065-6

Baumgärtner, S., & Quaas, M. (2010). What is sustainability economics? *Ecological Economics, 69*(3), 445–450. https://doi.org/10.1016/j.ecolecon.2009.11.019

Boehler, P. (2012). Bad Eggs: Another Fake-Food Scandal Rocks China. Time. Retrieved from http://newsfeed.time.com/2012/11/06/how-to-make-a-rotten-egg/.

Bollani, L., Bonadonna, A., & Peira, G. (2019). The Millennials' Concept of Sustainability in the Food Sector. *Sustainability, 11*(10), 2984. https://doi.org/10.3390/su11102984

Boobalan, K., & Nachimuthu, G. S. (2020). Organic consumerism: A comparison between India and the USA. *Journal of Retailing and Consumer Services, 53*, 101988. https://doi.org/10.1016/j.jretconser.2019.101988

Burton, I. (1987). Report on Reports: Our Common Future: The World Commission on Environment and Development. *Environment: Science and Policy for Sustainable Development, 29*(5), 25–29. https://doi.org/10.1080/00139157.1987.9928891

Carlson, A., & Jaenicke, E. C. (2016). Changes in Retail Organic Price Premiums from 2004 to 2010. *Retrieved from*. https://www.ers.usda.gov/publications/pub-details/?pubid=45550.

Cohen, M. J., & Garrett, J. L. (2010). The food price crisis and urban food (in)security. *Environment and Urbanization, 22*(2), 467–482. https://doi.org/10.1177/0956247810380375

Darré, E., Cadenazzi, M., Mazzilli, S. R., Rosas, J. F., & Picasso, V. D. (2019). Environmental impacts on water resources from summer crops in rainfed and irrigated systems. *Journal of Environmental Management, 232*, 514–522. https://doi.org/10.1016/j.jenvman.2018.11.090

de Schutter, O. (2010). Report submitted by the Special Rapporteur on the right to food. Paper presented at the UN General Assembly. Human Rights Council Sixteenth Session, Agenda item 3 A/HRC/16/49.

Ditlevsen, K., Denver, S., Christensen, T., & Lassen, J. (2020). A taste for locally produced food - Values, opinions and sociodemographic differences among 'organic' and 'conventional' consumers. *Appetite, 147*, Article 104544. https://doi.org/10.1016/j.appet.2019.104544

Dubé, L., Fatemi, H., Lu, J., & Hertzer, C. (2016). The Healthier the Tastier? USA–India Comparison Studies on Consumer Perception of a Nutritious Agricultural Product at Different Food Processing Levels. Frontiers. *Public Health, 4*(6). https://doi.org/10.3389/fpubh.2016.00006

eSvasa. (n.d.). Organic food India| Price Comparison - Organic food vs conventional food. Retrieved 6 September 2020 from http://www.esvasa.com/?q=organic_food_prices.

FAO. (2010). Sustainable diets and biodiversity directions and solutions for policy, research and action. Paper presented at the Proceedings of the International Scientific Symposium Biodiversity and Sustainable Diets United Against Hunger, Headquarters, Rome.

FAO. (2011). The state of the world's land and water resources for food and agriculture: managing systems at risk. In: O. Dubois (Ed.): Earthscan, London, UK.

FAO. (2017). The future of food and agriculture – Trends and challenges. Rome.

FAO. (2020). Km 0 - Litoral Norte. Retrieved from http://www.fao.org/family-farming/detail/es/c/286437/.

FAOSTAT. (2020). Food and Agriculture Organization of the United Nations database. Retrieved from http://faostat3.fao.org/faostat-gateway/go/to/home/S.

Feldmann, C., & Hamm, U. (2015). Consumers' perceptions and preferences for local food: A review. *Food Quality and Preference, 40*, 152–164. https://doi.org/10.1016/j.foodqual.2014.09.014

Glaser, C. (2010). Economics and sustainability Teaching Environmental Literacy: Across Campus and Across the Curriculum (pp. 61-71).

Green, H., Broun, P., Cook, D., Cooper, K., Drewnowski, A., Pollard, D., … Roulin, A. (2018). Healthy and sustainable diets for future generations. *Journal of the Science of Food and Agriculture, 98*(9), 3219–3224. https://doi.org/10.1002/jsfa.8953

Grunert, P. K. G. (2018). Drivers of food choice: A cognitive structure approach to the determinants of food choice and implications for affecting behavior change. *Nutrition, 55–56*, S4–S5. https://doi.org/10.1016/j.nut.2018.07.004

Hoekstra, A. Y., Chapagain, A. K., Aldaya, M. M., & Mekonnen, M. M. (2011). The Water Footprint Assessment Manual - Setting the Global Standard (Earthscan Ed.). London, UK.

IAASTD, International Assessment of Agricultural Knowledge, Science and Technology for Development. (2009). Agriculture at a Crossroads. International Assessment of Agricultural Knowledge, Science and Technology for Development Global Report, Island Press, Washington, D.C.

IFIC, International Food Information Council Foundation. (2018). One-third of Americans are dieting, including one in 10 who fast while consumers also hunger for organic, "natural" and sustainable. Retrieved from https://foodinsight.org/.

Jeswani, H. K., Burkinshaw, R., & Azapagic, A. (2015). Environmental sustainability issues in the food–energy–water nexus: Breakfast cereals and snacks. *Sustainable Production and Consumption, 2*, 17–28. https://doi.org/10.1016/j.spc.2015.08.001

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—a meta-analysis. *Global Environmental Change, 23*, 1028–1038.
Lagos, J. E., Scott, R. R., Rasmussen, K., Bugang, W., & Chen, U. (2010). Organics Report - People's Republic of China. *GAIN Report Number, 10046*. https://doi.org/10.1023/A:1011241000035
Mancini, P., Marchini, A., & Simeone, M. (2017). Which are the sustainable attributes affecting the real consumption behaviour? Consumer understanding and choices. *British Food Journal, 119*(8), 1839–1853. https://doi.org/10.1108/BFJ-11-2016-0574
Martins, A. P. d. O., Bezerra, M. d. F., Marques Júnior, S., Brito, A. F., Andrade neto, J. C. d., Galvao Júnior, J. G. B., . . . Rangel, A. H. d. N. (2020). Consumer behavior of organic and functional foods in Brazil. Food Science and Technology, 40, 469-475. https://doi.org/10.1590/fst.03519.
Masaquiza Moposita, D. A., Pereda Mouso, J., Curbelo Rodríguez, L. M., Figueredo Calvo, R., & Cervantes Mena, M. (2017). Intensificación de los sistemas agropecuarios y su relación con la productividad y eficiencia. Resultados con su aplicación: Artículo de Revisión. *Revista de Producción Animal, 29*, 57–64.
McLaughlin, D., & Kinzelbach, W. (2015). Food security and sustainable resource management. *Water Resources Research, 51*(7), 4966–4985. https://doi.org/10.1002/2015wr017053
Meyer-Höfer, M. v. (2014). Product Differentiation and Consumer Preferences for Sustainable Food. Georg-August-Universität Göttingen, Göttingen.
Moraes, J. M. M., Moraes, C. H. d. C., Souza, A. A. L. d., & Alvarenga, M. d. S. (2020). Food choice motives among two disparate socioeconomic groups in Brazil. Appetite, 155, 104790. Doi: 10.1016/j.appet.2020.104790.
OECD-FAO. (2018). Carne. In O. Publishing (Ed.), OCDE-FAO Agricultural Outlook 2017-2026 (pp. 15). Paris. https://doi.org/10.1787/agr_outlook-2017-10-es.
Phan, U. T. X., & Chambers, E. (2016). Motivations for choosing various food groups based on individual foods. *Appetite, 105*, 204–211. https://doi.org/10.1016/j.appet.2016.05.031
Phan, U. T. X., & Chambers, E., IV (2016). Application of An Eating Motivation Survey to Study Eating Occasions. *Journal of Sensory Studies, 31*(2), 114–123. https://doi.org/10.1111/joss.12197
Popa, M. E., Mitelut, A. C., Popa, E. E., Stan, A., & Popa, V. I. (2019). Organic foods contribution to nutritional quality and value. *Trends in Food Science & Technology, 84*, 15–18. https://doi.org/10.1016/j.tifs.2018.01.003
Prentice, C., Chen, J., & Wang, X. (2019). The influence of product and personal attributes on organic food marketing. *Journal of Retailing and Consumer Services, 46*, 70–78. https://doi.org/10.1016/j.jretconser.2017.10.020
R834/2007. Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91.
R889/2008. Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control.
Ramesh, P., Singh, M., & Rao, A. S. (2005). Organic farming: Its relevance to the Indian context. *Current Science, 88*(4), 561–568.
Reisch, L., Eberle, U., & Lorek, S. (2013). Sustainable food consumption: An overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy, 9*(2), 7–25. https://doi.org/10.1080/15487733.2013.11908111
Roser, M., Ritchie, H., & Ortiz-Ospina, E. (2015). Internet. *Our World in Data*. https://ourworldindata.org/internet.
Seninde, D. R., & Chambers, E., IV (2020). Comparing Four Question Formats in Five Languages for On-Line Consumer Surveys. *Methods and Protocols, 3*(3), 49.
Shattuck, A., & Holt-Giménez, E. (2010). Moving from Food Crisis to Food Sovereignty. *Yale Hum. Rts. & Dev. LJ, 13*, 421.
Springmann, M., Godfray, H. C. J., Rayner, M., & Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. *Proceedings of the National Academy of Sciences, 113*(15), 4146–4151. https://doi.org/10.1073/pnas.1523119113
Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., … Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science, 347*(6223), 1259855. https://doi.org/10.1126/science.1259855
Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature, 515*(7528), 518–522. https://doi.org/10.1038/nature13959
United Nations. (2012). The future we want. Paper presented at the Rio+20 United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil. https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf.
Vanham, D., Hoekstra, A. Y., & Bidoglio, G. (2013). Potential water saving through changes in European diets. *Environment International, 61*, 45–56. https://doi.org/10.1016/j.envint.2013.09.011
Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., … Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: Report of The Rockefeller Foundation Lancet Commission on planetary health. *The Lancet, 386*(10007), 1973–2028. https://doi.org/10.1016/S0140-6736(15)60901-1
Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., . . . Murray, C. J. L. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. The Lancet 393(10170), 447-492. https://doi.org/10.1016/S0140-6736(18)31788-4.
Yin, S., Wu, L., Du, L., & Chen, M. (2010). Consumers' purchase intention of organic food in China. *Journal of the Science of Food and Agriculture, 90*(8), 1361–1367. https://doi.org/10.1002/jsfa.3936
Yu, X., Gao, Z., & Zeng, Y. (2014). Willingness to pay for the "Green Food" in China. *Food Policy, 45*, 80–87. https://doi.org/10.1016/j.foodpol.2014.01.003

PUBLICACIÓN 2

CONSUMERS ATTITUDE TOWARDS THE SUSTAINABILITY OF DIFFERENT FOOD CATEGORIES

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Article

Consumers' Attitude towards the Sustainability of Different Food Categories

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Abstract: Currently, poverty, climate change, environmental pollution and the depletion of natural resources have generated a greater concern for sustainability. The objective is the survival of the human species and the persistence of all components of the biosphere. To achieve sustainability, human participation is essential; sustainable consumption depends on consumers' perceptions of sustainability and how they affect their behavior. The aim of this study was to understand consumers' perceptions and attitudes towards food sustainability based on country, age, gender, income and education level. An online survey was carried out in countries in Europe, America and Asia. Consumers were asked questions organized into food categories. The results showed that consumers' attitude towards sustainability is understood differently in each country, even within the same food category. Consumers with lower education level showed the lowest knowledge and concern about food sustainability. Older generations were less aware of sustainability and its related problems. While income level presented unclear results, gender did not affect attitude towards food sustainability. Therefore, to achieve a sustainable future, raising awareness among the population is increasingly necessary. Consequently, segmenting training campaigns according to the group they are aimed at will provide a greater impact and, therefore, greater awareness.

Keywords: consumers' perception; education level; environmental issues; generations; income

1. Introduction

Sustainability is more and more important due to current world problems such as poverty, climate change, environmental pollution and the finiteness of natural resources [1]. Sustainability arose as a concept in 1987, when it was defined in the Brundtland Report in terms of a goal: to "meet the needs of the present generation without compromising the ability of future generations to meet their own needs" [2]. Since then, many ways of defining sustainability have come emerged. Brown, et al. [3] pointed out some common features that are involved in the concept of sustainability: (i) the continued support of human life on earth; (ii) long-term maintenance of the stock of biological resources and the productivity of agricultural systems; (iii) stable human populations; (iv) limited growth economies; (v) an emphasis on small-scale and self-reliance; and (vi) continued quality of the environment and ecosystems.

The key aspect in defining sustainability is its anthropocentric perspective. The real objective is the survival of the human species across all regions of the world and the persistence of all components of the biosphere, even those with no apparent benefit to humanity [3]. However, all these depend on human behavior and supposes, at least, three core dimensions of sustainability [4]: (i) environmental (protection of natural environment and resources), (ii) social and cultural systems, and (iii) economics (promotion of decent human living conditions).

These three aspects are linked to consumption consequences [5]. In this sense, sustainable consumption and production are defined according to the United Nations Environment Programme (UNEP) [6] as a "holistic approach to minimize the negative environmental impacts from consumption and production systems while promoting quality of life for all". Paavola [7] provided the definition of sustainable consumption as "consumption that entails a reduction of the adverse impact on the environment".

Food consumption, distribution and production are key aspects of human life. There are several studies of the relation between food consumption and sustainability [8–10]. It is clear that consumers have a major role in making food chains more sustainable through the choices they make when buying food because these give information to producers about which foods, how they should be produced and where they must be sold [11]. In this sense, it could be said that, although the way food is produced can be changed, market forces (consumer demand) are one of the most important factors in the development of food chains [12].

Sustainable consumption patterns depend on the perceptions of sustainability that consumers have, how these perceptions build attitudes and how these attitudes affect their behavior. Consumer perception can be understood as the translation of sensory perception into buying behavior. In this sense, sensory perception is linked to the way that humans perceive and process sensory stimuli, but not only through their senses. Consumer perception relates also to how opinions about companies and their products are made. In the other direction, companies use consumer perception theory, firstly, to understand what consumers think about them and their offers and, secondly, to develop communication strategies to build loyalty of current consumers and to attract new ones.

As sustainability is linked to environment, it can be said that perception about sustainability is related to environmental concern. This concept can be defined as "an individual's perception and conviction that humans endanger the natural environment combined with the willingness to protect it" [13]. Researchers use this term to refer to the whole range of environmentally related perceptions, emotions, knowledge, attitudes, values and behaviors [14]. Thus, environmental concern would link perceptions, attitudes and behaviors. This concept holds, according to Franzen and Vogl [15], at least, three aspects: (i) the rational awareness of the problem, (ii) the emotional affection caused by the problem and (iii) the willingness to act to solve the problem.

Environmental concern can be analyzed as an awareness of consequences, using Schwartz's [16] norm activation theory of altruism. Empirical evidence shows that environmental concern has major effects on pro-environmental behavior and hence on sustainability perceptions and attitudes. In this sense, it would induce a sense of responsibility, a commitment to behave by following personal rules or moral obligations leading to environmentally protective actions [17]. Pro-environmental norms reflect the extent to which a person feels a personal obligation to contribute to the solution of an environmental problem [18].

Attitudes about environmental issues depend on the relative importance that a person places on himself/herself, humankind and the whole planet [19]. According to Stern and Dietz [20], these attitudes can be linked to environmental consequences, labelled as egoistic, social-altruistic, and bio-spheric consequences and related to three different underlying value orientations. So it can be said that environmental concerns arise because people become aware of harmful consequences to something that they value. However, this awareness is going to depend on people's perceptions. These perceptions will build people's attitudes and values.

An important aspect that derives from values is trust. Trust generally is understood as a situation characterized by the following aspects: one party (trustor) is willing to rely on the actions of another party (trustee); the situation is directed to the future. The trustee has control either because the trustor gave up that control or, in the case of environmental or sustainability issues, because the trustor has no way of confirming the action. This is included in the introduction as it is a key part of how values are created in a society. In this sense, environmental concern and perceptions on sustainability perception depend on values and on the degree of trust. It can be assumed that trust is linked to a strong concern about environmental issues. People show different levels of confidence towards other people and institutions. Trusting other people increases environmental concern [21] as it creates the belief that others are also concerned about environmental issues and are helping to provide and maintain public goods. According to this, trusting public institutions should also influence people's environmental concern. However, this is not so clear. Two questions have to be addressed. First, public institutions are responsible for providing public goods. People that do not trust public institutions can tend to think that environmental problems are not properly considered. People could be less ready also to provide public goods or services when they think that others (public institutions) are not fulfilling their tasks. So this is not a resolved aspect of the problem and, most importantly, it depends on people's perceptions about sustainability.

It is interesting to look at personal and national differences regarding environmental concern and perceptions and attitudes about sustainability. In this sense, environmental concern is strongly related to national wealth. People living in wealthier countries show higher environmental concern. The wealth of a country has a positive effect on individual environmental concern [19].

However, individual differences within a country are more defined than differences among countries. According to Franzen and Vogl [15], persons' environmental concern relies on socio-demographic characteristics such as gender, age, income and education. This could be explained looking at different social roles. Younger people show higher concern than older ones as they have grown up in times when the media focused more attention on the problem. However, environmental concern increases first and then drops as people get older. Income level is also related to environmental concern. The higher the income, the higher the concern about environmental problems. This can be explained looking at two facts. First, richer people do not worry about personal economic problems, so they can look at other questions. Second, richer people normally maintain a higher consumption of private goods and a higher demand for public goods. They present a higher willingness to pay for better goods. Finally, education is directly related to environmental concern [22]. The higher the knowledge about environmental problems, the higher the concern.

Furthermore, value orientations are also related to environmental concern. This can be understood looking at Inglehart's post-materialism hypothesis [23]. This theory proposes that societies face changes as they develop economically. Economic change creates generations with higher materialistic values (e.g., the desire for economic growth and price stability). Generations that grow in economic prosperity show stronger post-material values (freedom and self-realization). Post-material values are positively linked to environmental concern as economic prosperity is no longer a question to be solved.

Environmental concern becomes environmental behavior when people decide to act. A group of environmental behaviors are linked to the idea of frugality (use reduction, recycling and re-use of objects) [24]. A frugal attitude is linked to cooperative behavior in resource dilemmas, or to resource conservation behavior [25]. It requires motivation to save resources, an idea of "efficiency" and a strong confidence in other people. Obviously, these motivations depend on perceptions and attitudes about sustainability.

Consequently, sustainable food consumption has to be understood as a behavior that depends on perceptions about what a consumer buys and how production and distribution affect the environment. These perceptions can lead to attitudes that then predict behavior. This is why looking at people's perceptions about sustainability is a key factor to understand how and why they buy and eat food products.

The fact is that the more local and the more seasonal a food product is, the more sustainable it usually is, but this idea is not understood by the majority of population. As has been said, dietary change can deliver environmental benefits on a scale not achievable by producers [11]. Consumers can play another important role by avoiding high-impact producers [12]. This action needs previous awareness, and awareness depends on perceptions and attitudes. So communicating average product impacts to consumers is the first step to making dietary change possible, as it can help to change perceptions and, hence, attitudes. However, producers and society need to know which are these perceptions and attitudes and which are the main groups with faulty ideas about sustainability in order to develop communication strategies. The first hypothesis of this research was that consumers do not clearly understand the concept of environmental sustainability regarding food. The second was that consumers' perception of this concept differs depending on cultural background and personal characteristics. Thus, the main objective of this study was to understand consumer's perceptions and attitudes regarding sustainability in different food categories.

2. Materials and Methods

The development of a scale for measuring thoughts about sustainability is important to understand people's perceptions on sustainability, and how producers can attract consumers willing to buy goods that are eco-friendly and/or who want to support small producers.

A questionnaire was developed for a global study on sustainability, which was conducted with more than 3600 participants in 6 countries (Brazil, China, India, Mexico, Spain and the United States). The survey was completed by 50% of self-identified men and women. Four age ranges were selected (25% of participants for each age range), clearly differentiated: 18–23 years (centennials); 24–41 years (millennials); 42–52 years (gen X) and 53–73 years (baby boomers). Five levels of study were evaluated (primary school or less, high school diploma, associate's degree, bachelor's degree and graduate degree or higher) and 4 income ranges (25,000 US dollars or less, 25,001–50,000 US dollars, 50,001–100,000 US dollars and more than 100,000 US dollars). For income, each country studied adapted ranges (in the official currency of each country) to obtain results from the lower, middle and upper income classes of each country. Results for income have been expressed in US dollars.

The present study was conducted by Qualtrics (an online survey company). The survey was launched simultaneously in the six countries studied. Respondents did not receive a financial incentive; however, the Qualtrics database has a reward system to compensate respondents for their time and collaboration. The questions selected for the study were established through an expert discussion and following the model used by Sánchez-Bravo et al. [26].

The questionnaire used in the current study was included in a large survey analyzing multiple aspects of the sustainability of food categories. The questions were organized into 13 food categories: (I) bread and cereal products; (II) snacks; (III) sugar and derivatives; (IV) fruits and vegetables; (V) fats and oils; (VI) coffee, tea and cocoa; (VII) soft drinks and water; (VIII) alcoholic beverages; (IX) meat products; (X) eggs; (XI) milk and dairy products; (XII) fish and seafood; and (XIII) food for special dietary uses.

The questions were presented within the questionnaire in a random order. Socio-demographic questions were also evaluated. The survey was translated into five languages (English, Spanish, Portuguese, Hindi, and Mandarin Chinese). Verification of the translations was performed through a back translation. The survey was conducted online and was presented in each country in its most common official language. A cheating question was introduced to avoid consumers from responding randomly, ("salt is a flavor enhancer and I am trying to double my intake of salt"). Questionnaires containing the wrong answer for such question were removed from the study.

Responses were measured on a Likert type scales of 7 points (1: strongly disagree, 2: disagree, 3: disagree somewhat, 4: neither agree nor disagree, 5: agree somewhat, 6: agree, 7 strongly agree). Demographic data were obtained by multiple choice answers. The full questionnaire is presented in Table 1.

Table 1. Full questionnaire.

Number		Question
Q1		Demographics
Q2		Please indicate your agreement to the following questions.
	Q2.1	A nice plastic packaging is essential to sell sustainable snacks.
	Q2.2	A certification proving low environmental impact will help me in eating more meat products.
	Q2.3	Grains are always grown under rain-fed conditions, not with irrigation.
	Q2.4	Coffee beans from extremely small farms in the mountains of Jamaica deserve a high price to be fair to the farmers and support their economic future.
	Q2.5	Consuming farm raised fish is less sustainable than consuming sea-fish.
	Q2.6	Beef cattle are not sustainable because they have a high carbon footprint.
	Q2.7	Eating seafood can be risky due to the occurrence of mercury but it is so delicious that I cannot stop eating it.
	Q2.8	Eggs from free-range hens are more sustainable than those from caged-hens.
	Q2.9	Even though corn requires a high volume of water, I will never stop buying corn products because I like them too much.
	Q2.10	Even though I know that confections and cakes may not be good for my health, I cannot help it and still consume them often.
	Q2.11	Extra virgin olive oil is more sustainable than canola oil because it does not go through a refining process.
	Q2.12	Product labeled "Fair Trade" (e.g., some coffees or chocolates) are too expensive.
	Q2.13	For sure I will buy brown sugar if it is labeled with a high carbon and water footprint.
	Q2.14	Green-house vegetables are widely available and are safer and more sustainable than the rain-fed ones.
	Q2.15	Home distilled alcohols cannot be considered sustainable if they risk the consumers' health in any way.
	Q2.16	I do not think milk quality varies much and will buy any that is on sale.
	Q2.17	I will reduce my consumption of discretionary products (oils, sugars, alcohol) if that helps in the sustainability of the food chain.
	Q2.18	I like to buy fair trade products, because this certification makes me feel good about the product source.
	Q2.19	It is important to eat a variety of vegetables even if they are out of season.
	Q2.20	I will not buy bottled water because it is less sustainable than tap water.
	Q2.21	I would buy soft drinks in glass bottles if they were returnable and I will be rewarded.

Table 1. *Cont.*

Number	Question
Q2.22	If I had known that a particular food (for instance, oranges) is one of the foods producing more environmental impact, I would have reduced its consumption before.
Q2.23	If I could, I would prefer to buy eggs directly from the farmer.
Q2.24	Independent of the taste, drinking bottled water is safer than drinking tap water.
Q2.25	It is more sustainable to drink milk than eat cheese.
Q2.26	It is more sustainable to eat fresh fruit than dry fruit because energy is needed to dry the products.
Q2.27	Organic vegetables are the perfect choice for consumers because they are bacteria-free.
Q2.28	Packing cupcakes individually in crystal clear bags within a bigger plastic bag is sustainable because it allows consumption of smaller portions.
Q2.29	Proper selection of grains with low water requirements will help to protect the environment.
Q2.30	If I knew that an ancient grain, such as sorghum, uses less water than wheat or corn I would want products made from that if they tasted good.
Q2.31	Providing consumers that have special dietary needs with proper foods is also part of the sustainability of the food chain.
Q2.32	Reducing the intake of animal fats can be considered as a sustainable behavior because it reduces medical expenses.
Q2.33	Rice-based food for people with gluten sensitivity must be sustainable to ensure the best possible quality and safety.
Q2.34	Seasonal fruits are the most sustainable foods; they can be eaten directly from the plant.
Q2.35	Sustainable snacks are those prepared using grains that optimize the use of irrigation water.
Q2.36	The high demand for palm oil is seriously jeopardizing the forest in countries such as Indonesia and Malaysia.
Q2.37	The information on labels of snack food is so much that I just buy snacks from the best-known brands.
Q2.38	Making yogurt at home is more sustainable than buying it from the store.
Q2.39	Canned-fish products are non-sustainable because they generate tons of waste.
Q2.40	The traceability of the milk (where the milk comes from) used in the cheese I eat is an important buying driver for me.
Q2.41	Traditional peach varieties are sustainable because they increase biodiversity.
Q2.42	Vodka is a sustainable drink because is prepared using cereal grains or potatoes.
Q2.43	When drinking alcoholic beverages, I do not care about their nutrition or health effects.
Q2.44	White sugar is less sustainable than brown sugar because a whitening process must be done.
Q2.45	Yogurt made with unpasteurized milk is safe because of a sustainable fermentation process.

Bolt questions are the ones selected by the Cronbach's alpha and PCA analysis.

Statistical Analysis

The results were processed by one-way analysis of variance (ANOVA) followed by Tukey's multiple range test, with a confidence interval of 95% and significant difference was defined as $p < 0.05$. Reliability was tested using Cronbach's alpha (95% confidence), while questions were clustered using principle component analysis (PCA), both of which were ran using the software R (programming language). We also used PCA to cluster the questions and avoid similar questions. Euclidean distance by an agglomerative hierarchical method (Ward's) was used to group consumers into clusters. Software XLSTAT (2016.02.27444 version, Addinsoft, Paris, France) was used.

3. Results and Discussion

The total number of questions selected for analyzing the data was reduced to 19 (highlighted in grey color in Table 1) through Cronbach's alpha analysis and PCA analysis). These questions were the least similar to each other and, therefore, the most representative. Results are shown in Tables 2–4 and are divided into different food categories for easier discussion and understanding.

Table 2. Consumers opinion on food categories issues as affected by the "country" factor for the 19 selected questions.

Question	ANOVA †	Country					
		USA	China	Mexico	Brazil	Spain	India
Bread and cereal products							
Q2.29	NS	4.9	5.1	5.1	5.1	4.9	5.0
Q2.30	***	4.6 c ‡	4.9 b	5.2 a	4.9 b	4.8 bc	4.9 b
Sugar and derivatives							
Q2.17	***	4.3 d	5.0 bc	5.3 a	5.1 ab	4.8 c	5.0 bc
Fruits and vegetables							
Q2.26	***	4.8 c	5.1 ab	5.2 a	5.2 ab	4.9 bc	4.5 d
Q2.34	***	5.1 c	5.2 bc	5.8 a	5.1 c	5.4 b	5.4 b
Q2.41	***	4.5 c	4.9 a	5.0 a	4.5 c	4.7 bc	4.8 ab
Fats and oils							
Q2.11	***	4.4 de	4.4 e	5.1 ab	4.9 bc	5.3 a	4.7 cd
Q2.32	***	4.4 d	5.0 a	4.9 ab	4.8 ab	4.5 cd	4.6 bc
Coffee, tea and cocoa							
Q2.4	***	4.4 c	4.7 b	4.8 ab	4.4 c	4.9 a	4.9 a
Q2.18	***	4.5 c	4.7 bc	4.7 bc	5.0 a	4.5 c	4.9 ab
Soft drinks and water							
Q2.21	***	4.9 b	5.6 a	5.6 a	4.8 b	5.8 a	5.0 b
Alcoholic beverages							
Q2.15	***	4.4 c	4.4 c	5.4 a	4.9 b	5.0 b	4.8 b
Meat products							
Q2.2	***	4.0 d	4.3 c	4.8 a	4.7 ab	4.6 bc	3.9 d
Q2.6	***	4.0 bc	3.9 c	4.3 a	4.2 ab	4.0 c	4.3 a
Eggs							
Q2.8	***	4.7 d	5.2 bc	5.1 c	5.4 ab	5.6 a	4.6 d
Q2.23	***	5.2 c	5.6 b	5.9 a	5.9 a	5.9 a	5.2 c
Milk and dairy products							
Q2.25	***	4.0 b	4.7 a	4.0 b	4.0 b	3.8 b	4.8 a
Q2.38	***	4.1 e	4.5 d	5.0 bc	5.4 a	4.9 c	5.3 ab
Q2.40	***	3.8 d	5.0 a	4.4 bc	4.9 a	4.2 c	4.6 b

† NS, not significant ($p > 0.05$) and *** significant differences $p < 0.001$. ‡ Values followed by different letters, within the same question, were significantly different ($p < 0.05$).

Table 3. Consumers opinion on food categories issues as affected by the "age" and "gender" factors for the 19 selected questions.

Question	ANOVA †	Age				ANOVA †	Gender	
		18–23	24–41	42–52	53–73		Male	Female
Bread and cereal products								
Q2.29	NS	5.0	5.2	5.0	5.0	NS	5.0	5.0
Q2.30	***	5.0 ab‡	5.1 a	4.8 b	4.6 c	NS	4.8	4.6
Sugar and derivatives								
Q2.17	NS	4.9	5.0	4.9	4.8	NS	4.8	5.0
Fruits and vegetables								
Q2.26	NS	4.9	5.0	4.9	4.9	NS	4.9	5.0
Q2.34	***	5.2 b	5.5 a	5.3 ab	5.3 b	NS	5.3	5.3
Q2.41	NS	4.7	4.8	4.7	4.6	NS	4.8	4.7
Fats and oils								
Q2.11	***	4.6 b	4.9 a	4.8 a	4.8 a	NS	4.7	4.9
Q2.32	***	4.5 b	4.8 a	4.7 ab	4.7 ab	NS	4.7	4.7
Coffee, tea and cocoa								
Q2.4	***	4.8 a	4.9 a	4.5 b	4.4 b	NS	4.6	4.8
Q2.18	***	4.6 b	4.9 a	4.7 b	4.6 b	NS	4.7	4.7
Soft drinks and water								
Q2.21	***	5.4 a	5.4 a	5.3 ab	5.1 b	NS	5.4	5.2
Alcoholic beverages								
Q2.15	NS	4.7	4.9	4.7	4.9	NS	4.8	4.8
Meat products								
Q2.2	***	4.5 a	4.5 a	4.3 a	4.1 b	NS	4.4	4.4
Q2.6	NS	4.2	4.2	4.0	4.0	NS	4.0	4.2
Eggs								
Q2.8	***	5.1 ab	5.3 a	5.1 a	4.9 b	NS	5.0	5.1
Q2.23	***	5.6 bc	5.8 a	5.7 ab	5.5 c	NS	5.6	5.7
Milk and dairy products								
Q2.25	***	4.3 a	4.4 a	4.1 b	4.0 b	NS	4.3	4.1
Q2.38	***	4.8 ab	5.0 a	4.9 ab	4.7 b	NS	4.8	5.0
Q2.40	NS	4.4	4.6	4.5	4.4	NS	4.5	4.5

† NS, not significant ($p > 0.05$) and *** significant differences $p < 0.001$. ‡ Values followed by different letters, within the same question and the same factor, were significantly different ($p < 0.05$). Age: 18–23 years old (Centennials); 24–41 years old (Millennials); 42–52 years old (Gen X) and 53–73 years old (Baby Boomers).

Table 4. Consumers opinion on food category issues as affected by the "income" and "education" factors for the 19 selected questions.

Question	ANOVA †	Income (US Dollars)				ANOVA †	Education				
		≤25.000	25.001–50.000	50.001–100.000	>100.000		≤Primary School	High School	Associate's Degree	Bachelor's Degree	≥Graduate Degree
Bread and cereal products											
Q2.29	NS	5.0	5.0	5.0	5.2	***	4.4 b‡	5.1 a	4.9 a	5.1 a	5.0 a
Q2.30	NS	5.0	4.8	4.8	4.9	***	4.4 b	4.9 a	4.8 a	4.9 a	4.9 a
Sugar and derivatives											
Q2.17	NS	5.0	4.8	4.9	4.9	***	4.6 b	4.7 ab	4.8 ab	5.1 a	5.0 a
Fruits and vegetables											
Q2.26	***	4.9 b	4.9 b	4.9 b	5.2 a	NS	4.9	4.9	4.8	5.0	4.9
Q2.34	NS	5.4	5.3	5.2	5.4	***	4.8 c	5.2 b	5.3 ab	5.4 a	5.4 a
Q2.41	NS	4.7	4.7	4.7	4.8	***	4.2 b	4.6 ab	4.6 ab	4.8 a	4.7 a
Fats and oils											
Q2.11	NS	4.9	4.8	4.7	4.7	NS	4.6	4.8	4.9	4.7	4.9
Q2.32	NS	4.7	4.7	4.6	4.9	***	4.3 b	4.7 a	4.7 a	4.8 a	4.7 a
Coffee, tea and cocoa											
Q2.4	NS	4.7	4.6	4.6	4.8	***	4.5 b	4.5 b	4.5 b	4.8 a	4.7 a
Q2.18	NS	4.7	4.8	4.7	4.9	***	4.4 b	4.7 ab	4.5 b	4.8 a	4.8 a
Soft drinks and water											
Q2.21	NS	5.3	5.3	5.2	5.4	***	4.9 b	5.1 ab	5.4 a	5.4 a	5.3 a
Alcoholic beverages											
Q2.15	***	5.0 a	4.8 b	4.6 b	4.6 b	NS	4.7	4.7	4.8	4.7	4.9
Meat products											
Q2.2	NS	4.4	4.4	4.4	4.5	***	3.9 b	4.2 ab	4.5 a	4.4 a	4.4 a
Q2.6	***	4.2 b	4.1 b	3.9 b	4.7 a	NS	4.3	4.1	4.1	4.1	4.2
Eggs											
Q2.8	NS	5.1	5.1	5.1	5.3	NS	4.8	5.1	5.1	5.2	5.1
Q2.23	NS	5.7	5.6	5.6	5.7	NS	5.6	5.6	5.6	5.6	5.7
Milk and dairy products											
Q2.25	NS	4.2	4.2	4.2	4.3	***	4.0 b	4.2 ab	4.0 b	4.4 a	4.1 ab
Q2.38	***	5.1 a	4.8 b	4.8 b	4.7 b	***	5.1 a	4.8 ab	4.7 b	4.9 ab	5.0 a
Q2.40	***	4.4 b	4.5 b	4.5 b	4.8 a	NS	4.4	4.4	4.4	4.6	4.5

† NS, not significant ($p > 0.05$) and *** significant differences $p < 0.001$. ‡ Values followed by different letters, within the same question and the same factor, were significantly different ($p < 0.05$).

Bread and cereals. Regarding grains, the most representative questions were related to water consumption. Consumers from all countries, ages, genders and income level agreed on the need to select proper grain varieties with low water requirements to decrease their environmental impact (Tables 2–4, Q2.29). Only education level (Table 4, Q2.29) significantly affected this perception, consumers with the lowest educational level being those that considered such selection of grains less necessary. Regarding the willingness to consume an ancient grain, sorghum, which has low water requirements (Table 2, Q2.30) as a substitute for corn/wheat, there were significant differences due to country, age and educational level. The most developed countries (USA and Spain) felt reticent to replace wheat or corn, even if products made with sorghum tasted good. The fact that the USA is the largest corn producer, with almost 400 million tons, and wheat is the third most produced commodity in Spain, behind olives and barley [27], may have contributed to this reticence to replace corn and wheat. Worldwide consumers older than 42 and those consumers with only primary education were also reticent (Tables 2–4, Q2.30). This behavior was expected because environmental concern decreases as people's age increases [15,22,26]. However, interest in heritage cereals is increasing even among older consumers, with farmers and consumers tending towards local and sustainable production and purchase. In this sense, Wendin, et al. [28] showed that, although all consumers know about heritage cereals, their consumption is affected by geographical area, but not by level of education. Added to this is the concern of older consumers for their health and their willingness to pay more for traditional cereals.

Sugar and derivatives. Factors affecting perception of sugar sustainability were country and education level (Tables 2–4). Sugar consumption is very high worldwide. Every year, an average of 24 kg per person of sugar is consumed. However, in developed countries (European Union, USA, Canada, Australia and New Zealand) this consumption increases up to 35.5 kg [29]. Consumption is even higher in Mexico and Brazil (38.7 and 67.3 kg, respectively), the latter being the country that consumes the most sugar in the world [29]. On the other hand, China and India have a lower sugar consumption than the world average (11.7 and 20 kg, respectively). In this sense, Mexico and Brazil were the countries that were more willing to reduce their consumption if it helps food chain sustainability (Q2.17; 5.3 and 5.1, respectively). On the other hand, US consumers disagreed the most (4.3), as was the case worldwide with consumers of lower educational level (4.6). In the USA, sugar consumption, especially in sugar beverages, is widely spread [30] and its high consumption is linked with obesity, cardiovascular disease and diabetes [31]. Therefore, the World Health Organization (WHO) made a recommendation to consume less than 10% of necessary calories in the form of sugar in 2014 [32]. Furthermore, nutritional warnings, especially negative ones about health, are an important factor for consumers when buying a product [33]. In 2019, China, India and USA were the countries with the highest number of diabetes patients, although diabetes prevalence is relatively low (10.9, 8.9 and 13.3%, respectively) [34]. On the other hand, the diabetes prevalence of Brazil and Mexico reached 11.4 and 15.2% respectively [34]. In addition, Mexico was the country with the highest percentage of population with obesity or overweight, exceeding 75% [35]. Reducing sugar consumption is one of the main strategies to reduce obesity and overweight [36]. In this sense, due to the high incidence of diabetes among the population of Mexico and Brazil caused by high sugar consumption, and the high rate of overweight reported, it is possible that reducing sugar consumption is the strategy to be followed by these countries to reduce diabetes and diseases derived from the consumption of sugar, along with the overweight and obesity of the population.

Fruits and vegetables. Taking a view on seasonal fruit consumption (Tables 2–4, Q2.34), gender and income did not affect consumer preference. On the other hand, country, age and educational level significantly affected perceptions regarding sustainability in seasonal fruit and vegetables consumption. It is widely known that seasonal fruit consumption is more sustainable than that of non-seasonal fruits [37]. However, consumers in the USA, Brazil and China (5.1, 5.1 and 5.2, respectively) were not aware of issues of sustainability in seasonal fruit consumption. Worldwide consumers of the highest and lowest age ranges and consumers who only had primary school education did not consider

seasonal fruits as more sustainable. This is because, in general, a higher level of education implies a greater concern for environmental problems and sustainability [38], and possibly knowledge of fruit seasonality. On the other hand, seasonal fruits and vegetable consumption is based on flavor and freshness, whereas reducing environmental impact is seen as a secondary factor [37].

When asking about fresh versus dried fruits (Tables 2–4, Q2.26), only country and income factors affected responses. In India, fresh fruit consumption was not considered more sustainable than dry fruit consumption (4.5). This is consistent with the fact that fresh and dry fruit productions are an important part of the Indian economy [39]. On the other hand, consumers with the highest level of income were more aware of this fact (5.2). In this sense, Brooks et al. [37] found that a major part of food environmental impact comes from processing. Therefore, a processed product is going to be less sustainable than its fresh equivalent. Furthermore, Sánchez-Bravo et al. [26] demonstrated that consumers associate highly processed products, such as snacks, with a lower perception of "sustainability". On the other hand, the reasons for choosing a more or less processed food depend on lifestyle. The most active consumers prefer to buy less processed foods [40].

Regarding the use of traditional varieties to avoid loss of biodiversity (Tables 2–4, Q2.41), country and level of education were the factors that showed significant differences, in contrast to age, gender and income. Currently, loss of biodiversity is one of the biggest problems; it is not only an environmental problem, but also basic in ensuring food security. Consumption patterns and intensification of agriculture are the main causes of biodiversity loss. Promoting the use of traditional and indigenous varieties is one of the main mechanisms of action to avoid and/or manage biodiversity losses [41]. In this sense, consumers from India, Mexico and China gave the greatest importance to traditional varieties as an alternative to avoid the loss of biodiversity (4.8 and 4.9, respectively). The contrary happened with consumers worldwide with the lowest education level. It is widely accepted that a greater crop diversity and, therefore, smaller and/or adapted agricultural production positively influence the development of more sustainable and economically stronger agro-food systems [42,43]. Likewise, increasing biodiversity requires consumer acceptance of diverse products [42]; thus, it was not surprising that developing countries, such as India, Mexico or China, were more open to the consumption of traditional varieties. Furthermore, it was also to be expected that less academically educated consumers would be less aware of the problems arising from the loss of biodiversity (Table 4).

Fats and oils. Looking at olive oil as more sustainable than canola oil (Tables 2–4, Q2.11), gender, income and education level were the factors that did not affect consumer perception. By contrast, country and age showed significant differences. Olive oil is widely consumed in Spain [44,45], therefore it was expected that consumers in this country would have considered it more sustainable than canola oil. On the contrary, USA and China consume much less olive oil than soybean and canola oil [46], so it was not surprising that they were the countries that least agreed (4.4in both countries). Besides, younger generations worldwide did not consider olive oil as more sustainable than canola oil (Table 3). These results contrast with those obtained by Bollani, et al. [47], who established that, in general, the Millennial generation are more concerned with sustainability and environmental issues.

Regarding reducing animal fats as a sustainability enhancer (Tables 2–4, Q2.32), country, age and education level were the factors that affected perceptions. China, Mexico and Brazil agreed with the fact that reducing the consumption of animal fats is a sustainable behavior, while the USA and Spain were less in agreement, as well as younger and less educated consumers worldwide. Animal fats (tallow, butter, lard, etc.) are widely consumed today. The USA produces a large amount of tallow and fats, so it makes sense that it did not seek to reduce the consumption of this type of fat [46]. In Spain there are many traditional processed cured meat products containing high amounts of animal fat. Originally such meat products allowed the preservation of meat and the reduction/avoidance of food waste. On the other hand, it seems that younger generations worldwide are still not aware of the importance of reducing animal fat consumption, for both sustainability and health.

Coffee, tea and cocoa. With regard to the category "coffee, tea and cocoa", factors that showed significant differences were country, age and education level. Mexico, Spain and India were the

countries that most agreed (4.8, 4.9 and 4.9, respectively) that a higher price should be paid for coffee beans from small farms, because this is fair for farmers (Tables 2–4, Q2.4). On the other hand, the USA and Brazil were less in agreement with this statement (4.4 both countries). Sánchez-Bravo et al. [26] showed that US consumers do not consider small farmers as essential in maintaining sustainability. Furthermore, Brazil is the main coffee producer [27], so it was to be expected that they did not want small producers to be encouraged. This behavior was repeated in worldwide consumers over 42 years old and in consumers with an associate's degree or less (Tables 3 and 4). This showed that education is key when it comes to buying sustainable products: "the greater knowledge, the greater concern" [48].

Taking a view on fair trade certification (Tables 2–4, Q2.18), Brazil and India considered that fair trade certification guarantees the origin of the product and, therefore, makes the consumer feel better (5.0 and 4.9, respectively). Consumers between 24 and 41 years old worldwide, as well as those with the highest education levels, showed similar behavior (Tables 3 and 4). In contrast, USA and Spain did not value fair trade certification as much (4.5 both countries). The certification process of a product is key in establishing its acceptance among consumers [26,49]. In India, the consumption of organic food suffered in obtaining acceptance due to the lack of official certification that guarantees its origin [26,50]. On the other hand, in general, consumers worldwide have favorable expectations of foods labeled as "organic," and of other labels such as "eco-friendly," "local," "fair trade" or "natural". This effect is known as the "halo effect" [42]. In fact, research has shown that use of the term "organic" implies "naturalness" to consumers who may think those ingredients and products are more sustainable too [51,52]. However, consumers with health problems are less affected by this effect [42,53]. Older people have more health problems [54]. This seems to indicate why older consumers were less in agreement with fair trade certification. Also, younger generations worldwide show higher concern about environmental issues [26,47].

Soft drinks and water. Regarding returnable soft drinks consumption in glass bottles (Tables 2–4, Q2.21) country, age and income were important factors with respect to this category. China, Mexico and Spain were more in favor of consuming soft drinks from reusable glass bottles (5.6, 5.6 and 5.8, respectively). The use of returnable glass bottles reduces the eutrophication of the soil and the waste generated [55]. However, the use of returnable bottles requires inspection and decontamination of returned bottles [56]. This implies costs that, according to results, not all countries are willing to assume. Furthermore, sustainability of returnable glass bottles depends on the number of reuse cycles [55]. In contrast, oldest and least educated consumers worldwide gave the lowest scores (5.1 and 4.9, respectively) in willingness to buy returnable glass bottles. This reinforces the previous statement that education and age are determining factors in sustainable consumer behavior.

Alcoholic beverages. When asked about home distilled alcohol consumption (Tables 2–4, Q2.15), country and income factors significantly affected response. Alcohol consumption is related to an increased risk of cancer, stroke and liver cirrhosis, in addition to the social consequences derived [57]. Consumers from the most developed countries (Spain and USA) are those with the highest alcohol consumption (10.4 and 8.9 L per capita, respectively) [57]. Consumers in the USA and China were the least concerned about the risk of consuming home distilled alcohol (4.4 both). In the same way, consumers worldwide whose income level exceeds 25,001 US dollars agreed the least with the consumption of home distilled alcohol. Income level is also related to environmental concern in some cases [26]. The higher the income, the greater the concern for sustainability. This is reinforced by our results (Table 4).

Meat products. Regarding the question that providing a low environmental impact certification would increase meat consumption (Tables 2–4, Q2.2), country, age and education level showed significant differences in response. In general, Mexico and Brazil were the countries that indicated a more favorable opinion (4.8 and 4.7, respectively), as well as consumers worldwide under the age of 52 and with high school and primary school education or less. In contrast, US and Indian consumers disagreed that certification would help to increase their meat consumption. As previously mentioned, the certification of a product is an important factor in the consumer purchase decision [26,49]. In this

sense, trust in certification agencies is key. In the USA, consumers have full confidence in their certification agency (USDA: United States Department of Agriculture), while in India the certification system is less reliable [49]. This fact seems to explain why certification will not help Indian consumers to eat more meat. Furthermore, India is the main country with vegetarian populations, having the lowest meat supply in the world (3.78 kg per person) and most of the beef cattle is destined for dairy production [27,58].

Looking at beef cattle sustainability (Tables 2–4, Q2.6), only country and income factors presented significant differences. Mexico, Brazil and India considered that beef cattle is not sustainable due to the high carbon footprint it generates (Table 2). This behavior was also shown among consumers worldwide with the highest level of income. Currently, meat products represent 30% of total world food consumption [59]. Livestock production causes an increase in greenhouse emissions and negatively influences the water footprint and water pollution [60]. Therefore, reducing this type of meat would help to lower greenhouse gases and their impact on climate change. In addition, avoiding red meat consumption would help in the prevention of diseases related to the consumption of this type of meat: cardiovascular diseases and some types of cancer such as colorectal cancer [60]. Therefore, providing information to the consumer is essential in guaranteeing a sustainable future. Since livestock is a source of greenhouse gas emissions, the "low carbon diet" has become a new trend. Currently, to partly replace meat, meat diluents and other non-meat substances (with a high protein content) are being used. These products offer opportunities for reformulation of more healthful and sustainable meat products [61]. However, although environmental concern affects purchase intention, it is still vegetarian consumers who are willing to pay more for this type of product [62].

Eggs. Taking a view on the eggs category, factors that showed significant differences were country and age. Spain and Brazil think that eggs from free-range hens are more sustainable than those from caged-hens (Tables 2–4, Q2.8; 5.6 and 5.4, respectively) and, together with Mexico, they would prefer to be able to buy them directly from the farmer (Tables 2–4, Q2.23). In contrast, US and India consumers were the least in agreement with these claims. These results are related to those obtained by Rahmani, et al. [63] who found that free range chicken eggs were the preferred option for Spanish consumers. Consumers worldwide of the oldest generation thought that free-range chicken eggs are not more sustainable and were less willing to buy eggs directly from the farmer (5.9 and 5.5, respectively). In general, older people tend to have mobility problems, so traveling to the farm would be an extra effort that many of them could not perform. This fact could explain why consumers older than 53 years were reluctant to buy eggs directly from the farmer.

Milk and dairy products. Regarding milk traceability as an important aspect in the decision to purchase dairy foods (Tables 2–4, Q2.40), country and income were the factors that presented significant differences. In Brazil and China, consumers considered milk traceability key when buying cheese (4.9 and 5.0, respectively). This aspect was also important for consumers with an income level above 100,000 US dollars. Milk production intensification in Brazil in the last decade has increased. This has provoked environmental and economic stress [64]. In this sense, Brazilian consumer's concern about milk traceability could be a way of ensuring its local origin and, thereby, reducing environmental impact caused by increased production.

Looking at home-made yogurt consumption as more sustainable than that of yogurt bought from the store (Tables 2–4, Q2.38), only gender did not affect response. Country, age, income and education level were the factors that showed differences. Brazil and India were in agreement with home-made yogurt consumption (5.4 and 5.3, respectively). In contrast, in the USA consumers opted for the consumption of yogurt made away from home (4.1). This opinion was shared by older consumers, consumers with incomes above 25,001 US dollars and consumers with an education level between high school and bachelor's degree.

On the other hand, country, age and education level were the factors that affected the question relating to milk consumption as being more sustainable than that of its derivatives (Tables 2–4, Q2.25). China and India consumers (4.7 and 4.8, respectively), younger generations and, in general, higher

education levels, considered eating milk more sustainable than eating cheese. In general, the wealth of a country has a positive effect on environmental concern [19]. Therefore, it was to be expected that the USA and China would be the most aware. However, the USA did not behave as expected. On the other hand, results obtained for the factors of age and education strengthen the previously established fact that young generations and a high level of education lead to a greater concern for sustainability and the environment (Tables 3 and 4).

In summary, the determining factors in attitude of consumers to sustainability were country, age and education (Table 5). As mentioned above, sustainability depends on human behavior [3]. Today, many studies have been carried out on the sustainability of water in agriculture products, called "hydroSOS" ([65–71] and, in addition, hydroSOStainability markers have been determined, through which certification protocols have been prepared, both in the field and for the product itself [72,73]. In this way, it is produced in a more sustainable way and, in addition, the farmer obtains an additional benefit, not only in saving on the cost of water, but also in obtaining higher quality fruits [65,66,70,71,74], generating a cycle that culminates with the purchase of the product by the consumer. However, if the consumer is not able to identify or value sustainable products, the cycle is broken. Therefore, to achieve a sustainable future, raising awareness among the population is increasingly necessary. Consequently, segmenting training campaigns according to the group they are aimed at will provide a greater impact and, therefore, greater awareness.

Recent studies indicate that consumers interested in organic or local products could be the key to sustainable consumption. This consumer profile might accept new forms of production and new foods, such as those made with recycled ingredients [75].

Table 5. Summary of factors affecting consumers' attitude towards the sustainability of different food categories. (C1 = Bread and cereal products; C2 = Sugar and derivatives; C3 = Fruits and vegetables; C4 = Fats and oils; C5 = Coffee, tea and cocoa; C6 = Soft drinks and water; C7 = Alcoholic beverages; C8 = Meat products; C9 = Eggs; C10 = Milk and dairy products).

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Country	*†	*	***	**	**	*	*	**	**	***
Age	*	NS	*	**	***	*	NS	*	**	**
Gender	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Income	NS	NS	*	NS	NS	NS	*	*	NS	**
Education	**	*	**	*	**	*	NS	*	NS	**

† NS, all questions are not significant; *, one question significant different; **, two questions significant different; ***, three questions significant different ($p > 0.05$).

Consumer Clustering

Clustering (Figure 1) was carried out to group the different consumers studied according to their interest/knowledge of sustainability. Three main groups (C1, C2 and C3) were found with C1, consisting of 40.2% consumers (those highly interested in sustainability), C2 including 57.6% consumers (those consumers with some interest and concern about sustainability, but not at the highest level), and C3 representing consumers who were not at all concerned about sustainability. C3 included only 2.2% of the overall population of consumers in the countries studied.

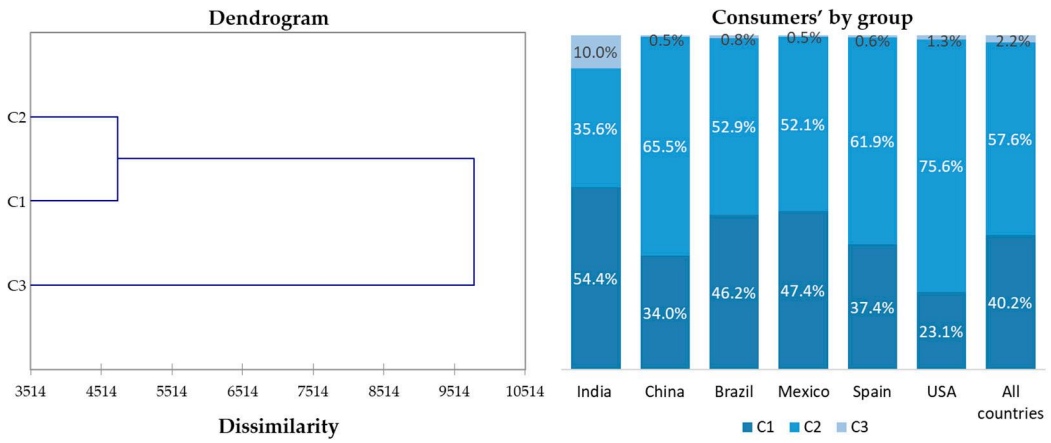

Figure 1. Dendrogram showing Euclidean distances between clusters and percentage of consumers of each group.

Consumers in C1 scored the highest for the questions most related to sustainability, while those in C2 scored somewhat lower, and consumers in C3 scored far lower on average than all other consumers for those questions (Table 6). For example, the mean scores for the 19 selected questions (Tables 3 and 4) ranged from 4.67 to 6.05 for C1, those most interested and concerned about sustainability. The mean consumer scores for C2 were lower than C1 by 0.5 to 1.5 points for all questions and ranged from 3.87 to 5.31. Scores for C3 were quite low (means = 1.42 to 2.12) indicating little or no interest in or concern about sustainability. Other authors have shown varying percentages of interest in specific products that have some sustainability attributes. For example, about 25% of consumers were not interested in sustainability labels for chocolate [76]. However, Dagevos and Voordouw [77] noted that percentages of consumers who were "willing to pay" for sustainability vary around the world and more consumers' indicate an interest in sustainability than actually show sustainable behaviors.

Table 6. Mean scores for each consumer cluster on each question used to differentiate among the clusters.

Question	Cluster 1	Cluster 2	Cluster 3
Q2.2	5.02	4.06	1.56
Q2.4	5.41	4.29	1.57
Q2.6	4.64	3.87	1.53
Q2.8	6.00	4.67	1.59
Q2.11	5.46	4.47	1.85
Q2.15	5.33	4.58	1.77
Q2.17	5.83	4.45	1.47
Q2.18	5.64	4.22	1.59
Q2.21	5.71	5.17	2.05
Q2.23	6.39	5.31	1.59
Q2.25	4.67	4.00	1.75
Q2.26	5.54	4.66	1.80
Q2.29	5.83	4.62	1.64
Q2.3	5.69	4.46	1.72
Q2.32	5.45	4.33	1.75
Q2.34	6.05	4.97	2.12
Q2.38	5.76	4.39	1.74
Q2.4	5.35	4.01	1.42
Q2.41	5.37	4.40	1.83

In this research, consumers in the USA were in the C2 group (75.6%) to a greater extent than in other countries. That is, they were concerned to a medium degree about sustainability. This was similar to consumers in China and Spain, although the percentages were slightly lower in that category. On the

other hand, Indian consumers showed contradictory behavior. More than half of Indian respondents (54.4%) were highly concerned about sustainability (C1), but, at the same time, India was the country with the highest percentage of consumers included in group C3 (10%), those who were not concerned with sustainability. Consumers from Brazil and Mexico were more equally divided between groups C1 and C2.

As mentioned previously, consumers in rich countries are more likely to show greater environmental concern. People who grow up under a prosperous income level, which guarantees their economic well-being, are generally more concerned about environmental problems [19]. This is reflected in the behavior of consumers in India, where the level of wealth is high in a portion of the population, but a significant percentage of the population is poor.

4. Conclusions

In general, it seems that consumers have not yet internalized environmental sustainability. Likewise, sustainability is understood differently in the different countries studied and depends on food category. Consumers of low educational level and older generations are less aware of and less interested in sustainability and the problems derived from it. Income level, while key in some food categories, is not fully indicative of consumer awareness of sustainability. Gender does not affect this same awareness, based on this data. Consumer awareness is key to achieving sustainability. In general, it can be seen how the level of education and age are the main factors that account for differences in consumers' concern related to food sustainability.

Because sustainability is understood differently in the countries studied and depends on food category and consumer demographics, it is crucial that policy makers develop a strategy for providing meaningful, accurate information about sustainability to various groups. How sustainability affects the specific foods people eat, the production processes for those foods, and how consumer behavior affects sustainability is one of the most important drivers for increased interest in sustainability. Because educational level and age were also found to be determinants for this perception, actions should be focused on promoting awareness among groups that show higher misperception. Starting by targeting information campaigns towards consumers with a lower level of education, segmented for each age and country, will be essential.

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References

1. Buerke, A.; Straatmann, T.; Lin-Hi, N.; Müller, K. Consumer awareness and sustainability-focused value orientation as motivating factors of responsible consumer behavior. *Rev. Manag. Sci.* **2017**, *11*, 959–991. [CrossRef]
2. Kuhlman, T.; Farrington, J. What is sustainability? *Sustainability* **2010**, *2*, 3436–3448. [CrossRef]

3. Brown, B.J.; Hanson, M.E.; Liverman, D.M.; Merideth, R.W. Global sustainability: Toward definition. *Environ. Manag.* **1987**, *11*, 713–719. [CrossRef]
4. Phipps, M.; Ozanne, L.K.; Luchs, M.G.; Subrahmanyan, S.; Kapitan, S.; Catlin, J.R.; Gau, R.; Naylor, R.W.; Rose, R.L.; Simpson, B. Understanding the inherent complexity of sustainable consumption: A social cognitive framework. *J. Bus. Res.* **2013**, *66*, 1227–1234. [CrossRef]
5. Brinkmann, J.; Peattle, K. Consumer ethics research: Reframing the debate about consumption for good. *EJBO Elect. J. Bus. Ethics Organ. Stud.* **2008**, *23*, 22–31.
6. UNEP, United Nations Environment Programme. Paving the Way for Sustainable Consumption and Production the Marrakech Process Progress Report. Available online: https://sustainabledevelopment.un.org/content/documents/947Paving_the_way_final.pdf (accessed on 30 July 2020).
7. Paavola, J. Towards sustainable consumption: Economics and ethical concerns for the environment in consumer choices. *Rev. Soc. Econ.* **2001**, *59*, 227–248. [CrossRef]
8. Siegrist, M.; Hartmann, C. Impact of sustainability perception on consumption of organic meat and meat substitutes. *Appetite* **2019**, *132*, 196–202. [CrossRef]
9. Steenis, N.D.; van Herpen, E.; van der Lans, I.A.; Ligthart, T.N.; van Trijp, H.C. Consumer response to packaging design: The role of packaging materials and graphics in sustainability perceptions and product evaluations. *J. Clean. Prod.* **2017**, *162*, 286–298. [CrossRef]
10. Verain, M.C.; Sijtsema, S.J.; Antonides, G. Consumer segmentation based on food-category attribute importance: The relation with healthiness and sustainability perceptions. *Food Qual. Prefer.* **2016**, *48*, 99–106. [CrossRef]
11. Poore, J.; Nemecek, T. Reducing food's environmental impacts through producers and consumers. *Science* **2018**, *360*, 987–992. [CrossRef]
12. Grunert, K.G. Sustainability in the food sector: A consumer behaviour perspective. *Int. J. Food Syst. Dynam.* **2011**, *2*, 207–218.
13. Fransson, N.; Gärling, T. Environmental concern: Conceptual definitions, measurement methods, and research findings. *J. Environ. Psychol.* **1999**, *19*, 369–382. [CrossRef]
14. Bamberg, S. Chapter 9: Understanding and Promoting Bicycle Use–Insights from Psychological Research. In *Cycling and Sustainability*; Transport and Sustainability; Emerald Group Publishing Limited: Bingley, UK, 2012; Volume 1, pp. 219–246.
15. Franzen, A.; Vogl, D. Two decades of measuring environmental attitudes: A comparative analysis of 33 countries. *Glob. Environ. Chang.* **2013**, *23*, 1001–1008. [CrossRef]
16. Schwartz, S.H. Normative influences on altruism. *Adv. Exp. Soc. Psychol.* **1977**, *10*, 221–279.
17. Kumar, B.; Manrai, A.K.; Manrai, L.A. Purchasing behaviour for environmentally sustainable products: A conceptual framework and empirical study. *J. Retail. Consum. Serv.* **2017**, *34*, 1–9. [CrossRef]
18. Stern, P.C. New environmental theories: Toward a coherent theory of environmentally significant behavior. *J. Soc. Issues* **2000**, *56*, 407–424. [CrossRef]
19. Klöckner, C.A. A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Glob. Environ. Chang.* **2013**, *23*, 1028–1038. [CrossRef]
20. Stern, P.C.; Dietz, T. The value basis of environmental concern. *J. Soc. Issues* **1994**, *50*, 65–84. [CrossRef]
21. Meyer, R.; Liebe, U. Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in switzerland. *Popul. Environ.* **2010**, *32*, 42–65. [CrossRef]
22. Zsóka, Á.; Szerényi, Z.M.; Széchy, A.; Kocsis, T. Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of hungarian high school and university students. *J. Clean. Prod.* **2013**, *48*, 126–138. [CrossRef]
23. Inglehart, R. *Modernization and Postmodernization: Cultural, Economic, and Political Change in 43 Societies*; Princeton University Press: Princeton, NJ, USA, 2020.
24. Fujii, S. Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. *J. Environ. Psychol.* **2006**, *26*, 262–268. [CrossRef]
25. Wilke, H.A. Greed, efficiency and fairness in resource management situations. *Eur. Rev. Soc. Psychol.* **1991**, *2*, 165–187. [CrossRef]
26. Sánchez-Bravo, P.; Chambers, V.E.; Noguera-Artiaga, L.; Sendra, E.; Chambers, E., IV; Carbonell-Barrachina, Á.A. How consumers perceive water sustainability (hydrosostainable) in food products and how to identify it by a logo. *Agronomy* **2020**, *10*, 1495. [CrossRef]

27. FAOSTAT. Food and Agriculture Organization of the United Nations Database. Available online: http://faostat3.fao.org/faostat-gateway/go/to/home/S (accessed on 16 July 2020).
28. Wendin, K.; Mustafa, A.; Ortman, T.; Gerhardt, K. Consumer awareness, attitudes and preferences towards heritage cereals. *Foods* **2020**, *9*, 742. [CrossRef]
29. OECD-FAO Agricultural Outlook. Sugar Projections: Consumption, Per Capita. 2015. Available online: https://www.oecd-ilibrary.org/docserver/agr_outlook-2015-table135-en.pdf?expires=1604398715&id=id&accname=guest&checksum=A1BCCD334F28C52A5F711961EE1A635A (accessed on 16 July 2020).
30. Drewnowski, A.; Rehm, C.D. Consumption of added sugars among us children and adults by food purchase location and food source. *Am. J. Clin. Nutr.* **2014**, *100*, 901–907. [CrossRef] [PubMed]
31. Hu, F.B.; Malik, V.S. Sugar-sweetened beverages and risk of obesity and type 2 diabetes: Epidemiologic evidence. *Physiol. Behav.* **2010**, *100*, 47–54. [CrossRef]
32. WHO, World Health Organization. WHO Opens Public Consultation on Draft Sugars Guideline. Available online: https://www.who.int/es/news-room/detail/05-03-2014-who-opens-public-consultation-on-draft-sugars-guideline (accessed on 16 July 2020).
33. Ares, G.; Antúnez, L.; Otterbring, T.; Curutchet, M.R.; Galicia, L.; Moratorio, X.; Bove, I. Sick, salient and full of salt, sugar and fat: Understanding the impact of nutritional warnings on consumers' associations through the salience bias. *Food Qual. Prefer.* **2020**, *86*, 103991. [CrossRef]
34. Statista. Ranking de los Países con Mayor Número de Enfermos de Diabetes en 2019. Available online: https://es.statista.com/estadisticas/612458/paises-con-mayor-numero-de-personas-con-diabetes/#:~{}:text=China%20fue%20el%20pa%C3%ADs%20con,los%20m%C3%A1s%20poblados%20del%20mundo (accessed on 16 July 2020).
35. OECD. Overweight Or Obese Population (Indicator). Available online: https://data.oecd.org/healthrisk/overweight-or-obese-population.htm (accessed on 16 July 2020).
36. Rathi, N.; Riddell, L.; Worsley, A. "Do you think adolescents' food intake is satisfactory?"—Views of indian parents and teachers. *Appetite* **2020**, *153*, 104740. [CrossRef]
37. Brooks, M.; Foster, C.; Holmes, M.; Wiltshire, J. Does consuming seasonal foods benefit the environment? Insights from recent research. *Nutr. Bull.* **2011**, *36*, 449–453. [CrossRef]
38. Mancini, P.; Marchini, A.; Simeone, M. Which are the sustainable attributes affecting the real consumption behaviour? Consumer understanding and choices. *Br. Food J.* **2017**, *119*, 1839–1853. [CrossRef]
39. Rather, N.A.; Lone, P.A.; Reshi, A.A.; Mir, M.M. An analytical study on production and export of fresh and dry fruits in jammu and kashmir. *Int. J. Sci. Res.* **2013**, *3*, 1–7.
40. Soroka, A.; Wojciechowska-Solis, J. Consumer motivation to buy organic food depends on lifestyle. *Foods* **2019**, *8*, 581. [CrossRef]
41. EU LIFE Project. Biodiversity in Standards and Labels for the Food Industry. Food and Biodiversity. Eu Life Programme LIFE15 GIE/DE/000737. 2019. Available online: https://www.business-biodiversity.eu/en/food-standards (accessed on 16 July 2020).
42. Aschemann-Witzel, J.; Ares, G.; Thøgersen, J.; Monteleone, E. A sense of sustainability?—How sensory consumer science can contribute to sustainable development of the food sector. *Trends Food Sci. Technol.* **2019**, *90*, 180–186. [CrossRef]
43. Holden, E.; Linnerud, K.; Banister, D. Sustainable development: Our common future revisited. *Glob. Environ. Chang.* **2014**, *26*, 130–139. [CrossRef]
44. Guzmán, G.I.; Alonso, A.M. A comparison of energy use in conventional and organic olive oil production in spain. *Agric. Syst.* **2008**, *98*, 167–176. [CrossRef]
45. COI. Consejo Oleícola Internacional: Evolución de Aceite a Nivel Mundial y Europeo. Available online: http://www.internationaloliveoil.org/estaticos/view/131-world-olive-oil-figures (accessed on 16 July 2020).
46. IHS-Markit. Fats and Oils Industry Overview. Available online: https://ihsmarkit.com/products/fats-and-oils-industry-chemical-economics-handbook.html (accessed on 16 July 2020).
47. Bollani, L.; Bonadonna, A.; Peira, G. The millennials' concept of sustainability in the food sector. *Sustainability* **2019**, *11*, 2984. [CrossRef]
48. Yin, S.; Wu, L.; Du, L.; Chen, M. Consumers' purchase intention of organic food in china. *J. Sci. Food Agric.* **2010**, *90*, 1361–1367. [CrossRef]
49. Prentice, C.; Chen, J.; Wang, X. The influence of product and personal attributes on organic food marketing. *J. Retail. Consum. Serv.* **2019**, *46*, 70–78. [CrossRef]

50. Boobalan, K.; Nachimuthu, G.S. Organic consumerism: A comparison between india and the USA. *J. Retail. Consum. Serv.* **2020**, *53*, 101988. [CrossRef]
51. Chambers, E.; Chambers, E., IV; Castro, M. What is "natural"? Consumer responses to selected ingredients. *Foods* **2018**, *7*, 65. [CrossRef]
52. Chambers, E.; Tran, T.; Chambers, E., IV. Natural: A $75 billion word with no definition—Why not? *J. Sens. Stud.* **2019**, *34*, e12501. [CrossRef]
53. Apaolaza, A.; Vigo, M. Wevquery: Testing hypotheses about web interaction patterns. *Proc. ACM Hum. Comput. Interact.* **2017**, *1*, 4. [CrossRef]
54. Fuentes, A.J.M.; Díaz, I.E.F. Ancianos y salud. *Rev. Cuba. Med. Gen. Integral* **2008**, *24*, 1–7.
55. Mata, T.M.; Costa, C.A.V. Life cycle assessment of different reuse percentages for glass beer bottles. *Int. J. Life Cycle Assess.* **2001**, *6*, 307–319. [CrossRef]
56. Nardi, P.C.C.; Silva, R.L.M.D.; Ribeiro, E.M.S.; Oliveira, S.V.W.B.D. Proposal for a methodology to monitor sustainability in the production of soft drinks in ref pet. *J. Clean. Prod.* **2017**, *151*, 218–234. [CrossRef]
57. OECD. Alcohol Consumption (Indicator). Available online: https://data.oecd.org/healthrisk/alcohol-consumption.htm#indicator-chart (accessed on 16 July 2020).
58. OECD-FAO. Carne. In *OCDE-FAO Agricultural Outlook 2017–2026*; OECD: Paris, France, 2018; p. 15.
59. Bonnet, C.; Bouamra-Mechemache, Z.; Réquillart, V.; Treich, N. Viewpoint: Regulating meat consumption to improve health, the environment and animal welfare. *Food Policy* **2020**, 101847. [CrossRef]
60. González, N.; Marquès, M.; Nadal, M.; Domingo, J.L. Meat consumption: Which are the current global risks? A review of recent (2010–2020) evidences. *Food Res. Int.* **2020**, *137*, 109341. [CrossRef]
61. Pintado, T.; Delgado-Pando, G. Towards more sustainable meat products: Extenders as a way of reducing meat content. *Foods* **2020**, *9*, 1044. [CrossRef]
62. Shen, Y.-C.; Chen, H.-S. Exploring consumers' purchase intention of an innovation of the agri-food industry: A case of artificial meat. *Foods* **2020**, *9*, 745. [CrossRef]
63. Rahmani, D.; Kallas, Z.; Pappa, M.; Gil, J.M. Are consumers' egg preferences influenced by animal-welfare conditions and environmental impacts? *Sustainability* **2019**, *11*, 6218. [CrossRef]
64. Ruviaro, C.F.; de Leis, C.M.; Florindo, T.J.; de Medeiros, F.G.I.B.; da Costa, J.S.; Tang, W.Z.; Pinto, A.T.; Soares, S.R. Life cycle cost analysis of dairy production systems in southern brazil. *Sci. Total. Environ.* **2020**, *741*, 140273. [CrossRef]
65. Cano-Lamadrid, M.; Hernández, F.; Corell, M.; Burló, F.; Legua, P.; Moriana, A.; Carbonell-Barrachina, Á.A. Antioxidant capacity, fatty acids profile, and descriptive sensory analysis of table olives as affected by deficit irrigation. *J. Sci. Food Agric.* **2017**, *97*, 444–451. [CrossRef]
66. Carbonell-Barrachina, A.A.; Memmi, H.; Noguera-Artiaga, L.; del Carmen Gijón-López, M.; Ciapa, R.; Pérez-López, D. Quality attributes of pistachio nuts as affected by rootstock and deficit irrigation. *J. Sci. Food Agric.* **2015**, *95*, 2866–2873. [CrossRef]
67. Fernandes-Silva, A.A.; Falco, V.; Correia, C.M.; Villalobos, F.J. Sensory analysis and volatile compounds of olive oil (cv. Cobrançosa) from different irrigation regimes. *Grasas Aceites* **2013**, *64*, 59–67. [CrossRef]
68. López, G.; Echeverria, G.; Bellvert, J.; Mata, M.; Behboudian, M.H.; Girona, J.; Marsal, J. Water stress for a short period before harvest in nectarine: Yield, fruit composition, sensory quality, and consumer acceptance of fruit. *Sci. Hortic.* **2016**, *211*, 1–7. [CrossRef]
69. Noguera-Artiaga, L.; Lipan, L.; Vázquez-Araújo, L.; Barber, X.; Pérez-López, D.; Carbonell-Barrachina, Á.A. Opinion of spanish consumers on hydrosustainable pistachios. *J. Food Sci.* **2016**, *81*, S2559–S2565. [CrossRef] [PubMed]
70. Noguera-Artiaga, L.; Sánchez-Bravo, P.; Hernández, F.; Burgos-Hernández, A.; Pérez-López, D.; Carbonell-Barrachina, Á.A. Influence of regulated deficit irrigation and rootstock on the functional, nutritional and sensory quality of pistachio nuts. *Sci. Hortic.* **2020**, *261*, 108994. [CrossRef]
71. Noguera-Artiaga, L.; Sánchez-Bravo, P.; Pérez-López, D.; Szumny, A.; Calin-Sánchez, Á.; Burgos-Hernández, A.; Carbonell-Barrachina, Á.A. Volatile, sensory and functional properties of hydrosos pistachios. *Foods* **2020**, *9*, 158. [CrossRef]

72. Corell, M.; Martín-Palomo, M.J.; Sánchez-Bravo, P.; Carrillo, T.; Collado, J.; Hernández-García, F.; Girón, I.; Andreu, L.; Galindo, A.; López-Moreno, Y.E.; et al. Evaluation of growers' efforts to improve the sustainability of olive orchards: Development of the hydrosostainable index. *Sci. Hortic.* **2019**, *257*, 108661. [CrossRef]
73. Sánchez-Bravo, P.; Collado-González, J.; Corell, M.; Noguera-Artiaga, L.; Galindo, A.; Sendra, E.; Hernández, F.; Martín-Palomo, M.J.; Carbonell-Barrachina, Á.A. Criteria for hydrosos quality index. Application to extra virgin olive oil and processed table olives. *Water* **2020**, *12*, 555. [CrossRef]
74. Lipan, L.; Martín-Palomo, M.J.; Sánchez-Rodríguez, L.; Cano-Lamadrid, M.; Sendra, E.; Hernández, F.; Burló, F.; Vázquez-Araújo, L.; Andreu, L.; Carbonell-Barrachina, Á.A. Almond fruit quality can be improved by means of deficit irrigation strategies. *Agric. Water Manag.* **2019**, *217*, 236–242. [CrossRef]
75. Perito, M.A.; Coderoni, S.; Russo, C. Consumer attitudes towards local and organic food with upcycled ingredients: An italian case study for olive leaves. *Foods* **2020**, *9*, 1325. [CrossRef]
76. Silva, A.R.D.A.; Bioto, A.S.; Efraim, P.; Queiroz, G.D.C. Impact of sustainability labeling in the perception of sensory quality and purchase intention of chocolate consumers. *J. Clean. Prod.* **2017**, *141*, 11–21. [CrossRef]
77. Dagevos, H.; Voordouw, J. Sustainability and meat consumption: Is reduction realistic? *Sustain. Sci. Pract. Policy* **2013**, *9*, 60–69. [CrossRef]

RESULTADOS Y DISCUSIÓN

5

Sostenibilidad General

Para los consumidores, las principales características (marcadas por ≥30 % de los consumidores en todo el mundo) de un producto sostenible son: (1) recomendaría su compra a mi familia / amigos; (2) son respetuosos con el medio ambiente; (3) existe la necesidad de un logo que los identifique claramente; (4) son auténticos porque aseguran un futuro adecuado de la agricultura; (5) son más saludables; (6) son más caros; (7) se producen de forma más tradicional; (8) se cultivan o producen con menos productos químicos; (9) son más sabrosos; (10) aumentan mi confianza; (11) tienen mejor calidad; y, (12) se ven naturales.

Los resultados mostraron que los consumidores de cada país tienen diferentes formas de explicar qué propiedades tiene un producto sostenible o la forma en que se cultivan y producen. La mayoría de los consumidores están de acuerdo en que son "amigables con el medio ambiente" y, la mayoría piensa, son "más saludables", usan "pocos químicos" en su producción y "tienen mejor calidad". Muchos de estos términos también se asocian con frecuencia con la producción ecológica (Boobalan y Nachimuthu, 2020; Popa *et al.*, 2019).

Disposición a pagar

En cuanto a la "disposición a pagar" un mayor precio por productos sostenibles, de manera general, se encontró que el 70 % de los consumidores de Estados Unidos y España estaban dispuestos a pagar más por productos sostenibles. Este porcentaje se incrementó hasta el 80 % en el caso de China, México y Brasil y alcanzó incluso porcentajes más altos en el caso de India (~ 86 %).

En general, hubo una tendencia similar entre los países más desarrollados (España y EE.UU.), mientras que India fue el país con mayor disposición a pagar. La certificación de los productos puede ser un factor determinante a la hora de determinar su compra (Prentice *et al.*, 2019). Por ejemplo, en el caso de los productos ecológicos, los consumidores indios eran más propensos a aceptar y comprar tales productos, debido a su creencia de que son más beneficiosos y saludables; sin embargo, su integración y consumo en el mercado indio resultó complicada debido a que los productores de alimentos ecológicos no siguieron los sistemas de certificación (Dubé *et al.*, 2016). Por el contrario, los consumidores estadounidenses confían plenamente en el cumplimiento de los estándares establecidos por la agencia de certificación del USDA (Departamento de Agricultura de los Estados Unidos), lo que hace que sus ventas sean más fáciles y seguras; sin embargo, incluso con estas ventajas, los consumidores estadounidenses

siguen prefiriendo los alimentos convencionales porque creen que su sabor es más intenso (Dubé *et al.*, 2016; Feldmann y Hamm, 2015).

Múltiples aspectos de la sostenibilidad de las categorías de alimentos

Se realizó una agrupación de los diferentes consumidores estudiados según su interés/conocimiento sobre sostenibilidad en las diferentes categorías de alimentos. El clúster realizado reveló 3 grupos principales (C1, C2 y C3). El grupo C1, formado por un 40,2 % de consumidores, incluyó a aquellos consumidores muy interesados en la sostenibilidad. El grupo C2, que incluía un 57,6 % de consumidores, agrupaba a aquellas personas más o menos preocupadas por la sostenibilidad, pero no en un nivel alto. Finalmente, el grupo C3 representó a consumidores que no estaban preocupados en absoluto por la sostenibilidad. Este grupo no fue nada destacable ya que solo estaba compuesto por un 2,2 % de consumidores.

En general, se puede decir que los consumidores de EE. UU. se encontraban en el grupo C2 (75,6 %) en mayor medida, es decir, no estaban tan preocupados por la sostenibilidad. Por otro lado, los consumidores indios mostraron comportamientos contradictorios. En primer lugar, más de la mitad de los encuestados indios (54,4 %) estaban muy preocupados por la sostenibilidad, pero, al mismo tiempo, India era el país con mayor porcentaje de consumidores incluidos en el grupo C3 (10 %), es decir, con mayor número de personas que no se preocupan en absoluto por la sostenibilidad. Los consumidores del resto de países se dividieron por igual entre los grupos C1 y C2.

Como se mencionó anteriormente, los consumidores de los países ricos tienen más probabilidades de mostrar una mayor preocupación por el medio ambiente. Las personas que crecen con un nivel de ingresos próspero, que garantiza su bienestar económico, están más preocupadas por los problemas ambientales (Klöckner, 2013). Esto se refleja en el comportamiento de los consumidores en India, donde el nivel de riqueza es alto, pero un porcentaje significativo de la población es pobre.

Sostenibilidad del agua en categorías de alimentos

Los resultados mostraron que las categorías de alimentos señaladas por los consumidores internacionales con necesidad de ahorrar agua durante su cultivo, producción y/o preparación, independientemente del país, eran: (i) cereales y productos a base de granos y (ii) vegetales, nueces y legumbres. Por el contrario, los consumidores piensan que no hay forma de ahorrar agua en la producción de snacks, refrescos y agua embotellada. Asimismo, se pidió a los consumidores que eligieran las 3 categorías de alimentos en las que se necesita más atención y

trabajo para ahorrar agua durante el cultivo, la producción y la preparación. Los resultados indicaron que "cereales y productos a base de granos", "frutas y zumos" y "verduras, nueces y legumbres" fueron los 3 principales productos donde se debe prestar esfuerzo y atención según los consumidores, especialmente en cereales y verduras, dejando al margen los productos cárnicos o la producción animal. El uso de riego en sistemas agrícolas conduce a mayores rendimientos y también produce un alto impacto en la sostenibilidad del agua (Darré *et al.*, 2019), sin embargo, los productos ricos en proteínas (por ejemplo, cordero, queso, carne de cerdo y guisantes y nueces), el aceite de oliva y la leche son los alimentos que necesitan mayores volúmenes de agua dulce (Poore y Nemecek, 2018). Además, los valores más altos de la huella hídrica de la Unión Europea (UE) están relacionados con el consumo de leche, carne de vacuno y porcino (Vanham y Bidoglio, 2013).

Es importante señalar la falta de asociación entre el grupo "verduras y frutas" con los "snacks", que no fueron asociados con el término "sostenibilidad" por parte de los consumidores. Esto muestra que los consumidores asociaron el consumo de agua principalmente con la producción primaria de alimentos, dejando de lado el proceso de elaboración y transformación de los alimentos. De hecho, en España, más del 85 % del consumo de productos ecológicos se debe a frutas y verduras (Cerdeño, 2010). No existe una conexión clara en la mente de los consumidores entre los alimentos procesados, como los *snacks*, con el agua de riego, que les parece que solo se utiliza para productos primarios como frutas y verduras. Esa idea está en conflicto directo con el concepto de la huella hídrica, que incluye mucho más que el insumo agrícola de agua (Hoekstra *et al.*, 2011).

Identificación y etiquetado de productos hidroSOStenibles

Los resultados mostraron que el logotipo fue calificado positivamente por la mayoría de los consumidores internacionales. En India, el logo fue calificado como mucho más atractivo para los consumidores (5,3) que en países como España y EE.UU. (4,1 y 4,3, respectivamente); aunque cabe señalar que en todos los países recibió valoraciones positivas. Las generaciones jóvenes (*Centennials*, *Millennials* y generación X) calificaron mejor el logotipo (4,6, 4,8 y 4,6, respectivamente) que las generaciones mayores (*baby boomers*, 4,4). Esto muestra que, en general, el nivel de satisfacción con el logotipo disminuyó a medida que aumentaba la edad de los consumidores. Los consumidores jóvenes parecen estar más enfocados en la información visual que los de mayor edad, quienes están más enfocados en la información escrita; los casos de éxito que respaldan esta afirmación son el uso de redes sociales y emoticonos por parte de los jóvenes. Además, las generaciones jóvenes están más

preocupadas por el medio ambiente y la sostenibilidad y tienen más confianza en el etiquetado de los alimentos como fuente de información (Bollani *et al.*, 2019). No hubo diferencias estadísticamente significativas para los factores género, ingreso anual o nivel educativo.

En cuanto al uso del logo, los consumidores de México, Brasil y España (6,0, 5,8 y 5,8, respectivamente) fueron los que más estuvieron de acuerdo en que el logo facilitó la identificación de los productos hidroSOStenibles, mientras que los consumidores chinos (4,8) fueron más reticentes, aunque también estuvieron de acuerdo en que el logo ayudaba a su identificación. Los consumidores en los grupos de edad media (*Millennials* y generación X) estuvieron más de acuerdo con la utilidad del logo propuesto, mientras que los consumidores en edades extremas (los más jóvenes y los mayores) dieron puntuaciones más bajas. Esto puede deberse a que los mayores prefieren leer el etiquetado antes que basar su elección en aspectos visuales. En cualquier caso, la puntuación media para esta pregunta fue de 5,6 (con 5 = algo de acuerdo y 6 = de acuerdo) y demostró claramente que el uso del logo o la implementación de la marca hidroSOS serviría para crear un medio de diferenciación para consumidores. Además, el nivel de educación de los participantes tuvo una influencia significativa en la opinión de los consumidores sobre el logotipo, ya que los consumidores que tenían el menor nivel educativo (estudios primarios) dieron las puntuaciones más bajas (4,9) a diferencia de los que tenían el bachiller o superior (5,6). Estos resultados son similares a los obtenidos por Ditlevsen *et al.* (2020), quienes informaron que, en general, los consumidores altamente educados eran los mayores compradores de alimentos ecológicos. Sin embargo, no hubo diferencias estadísticamente significativas debido al género y los ingresos anuales para la utilidad del logotipo.

Estos resultados coincidieron con nuestra hipótesis inicial sobre la necesidad de brindar más información a los consumidores especificando que son respetuosos con el medio ambiente. El desarrollo de un logo hidroSOStenible significaría brindar la información necesaria al consumidor, y con ella, brindar una transparencia total, derivada de un proceso de certificación asociado al logo, que el consumidor necesita para confiar y comprar el producto (Boobalan y Nachimuthu, 2020). Hoy en día, los consumidores en el mercado pueden encontrar más de 200 logotipos referentes a productos con aspectos saludables y sostenibles. Además, estas etiquetas, en algunos casos, compiten entre sí, lo que crea confusión y desconfianza entre los consumidores (Institute of Organic Agriculture FiBL. e IFOAM, 2019). En este sentido, se debe realizar un trabajo importante día a día para difundir el significado (aumento de la acumulación de compuestos bioactivos como respuesta al estrés hídrico) y los controles (en la finca y en el producto a comercializar) que se realizan sobre el logo hidroSOStenible para hacer que sea

ampliamente aceptado por los consumidores internacionales. La herramienta más importante para ganar la confianza de los consumidores sería desarrollar procesos de certificación y garantizar una transparencia total en el proceso de certificación, que debe basarse en resultados e indicadores científicos. En un estudio sobre la comercialización de productos ecológicos, Prentice *et al.* (2019) sugirió que, para los consumidores chinos, el factor más importante para la compra de productos ecológicos y que demuestra su autenticidad, es su certificación y etiquetado. Además, este logotipo y el desarrollo de un procedimiento de certificación transparente podría ser una opción importante para que los consumidores confíen en los productos hidroSOStenibles y estén seguros de la calidad y el origen del producto a comprar.

Con respecto al área del logo que más destaca, la gota de agua fue la que resultó más llamativa a la mayoría de los consumidores en todos los países estudiados. La palabra "hidro" está bien asociada con la gota de agua que se encuentra en el centro de la imagen y, por lo tanto, juega un papel clave en el logotipo. La siguiente área más atractiva fue la expresión "SOS", que era muy relevante en todos los países excepto en China e India, lo que podría deberse a la diferencia gramatical y a lo fácil que es entender el concepto de SOS como pedir ayuda (por ejemplo, *save our ship* o *save our souls*). Estudios anteriores revelaron que los consumidores prefieren etiquetas simples y fáciles de entender en comparación con etiquetas más complejas, aunque se proporciona información más detallada (Leach *et al.*, 2016). Por lo tanto, comprender la percepción del consumidor es esencial para comprender por qué algunas campañas de marketing no alcanzan sus objetivos específicos.

CONCLUSIONES
CONCLUSIONS

6

CONCLUSIONES

En general, los consumidores asocian la producción sostenible con los productos ecológicos y, a su vez, asocian los productos ecológicos con una mayor calidad y beneficios para la salud. En todos los países, los consumidores piensan que las categorías de alimentos en las que se puede ahorrar más agua durante toda su cadena de producción y distribución son aquellas relacionadas con el consumo primario, como los cereales y las verduras. Este hallazgo muestra claramente que los consumidores no asocian el procesado de alimentos (por ejemplo, *snacks*) con el consumo de agua.

Los factores determinantes en la actitud sostenible de los consumidores fueron el país, la edad y la educación. Los consumidores de países más desarrollados (España y EE.UU.) se mostraron más reticentes a pagar un aumento en el precio por productos sostenibles. Los consumidores con un mayor nivel de educación mostraron una mayor preocupación por la sostenibilidad y el medio ambiente y estaban dispuestos a pagar un precio más alto por productos sostenibles. La misma tendencia fue válida para los *millennials*, quienes mostraron una mayor preocupación por el medio ambiente y, junto con la generación X, una mayor disposición a pagar por productos sostenibles.

El logo propuesto para los productos hidroSOStenibles fue valorado positivamente, especialmente por las generaciones jóvenes, y se consideró útil para la identificación de estos alimentos sostenibles.

La conciencia del consumidor es clave para lograr la sostenibilidad. Se podría decir que los consumidores aún no han internalizado la sostenibilidad ambiental. La sostenibilidad se entiende de manera diferente en los diferentes países estudiados y dependiendo de la categoría de alimentos. Los consumidores de bajo nivel educativo y las generaciones de mayor edad son menos sensibles a la sostenibilidad y los problemas derivados de ella. El nivel de ingresos, si bien es clave en algunas categorías de alimentos, no es indicativo de la conciencia de los consumidores sobre la sostenibilidad. El género no afecta a la percepción de sostenibilidad. En consecuencia, es necesario segmentar las campañas de formación según el colectivo al que vayan dirigidas para conseguir un mayor impacto.

En general, se puede ver cómo el nivel de estudios y la edad son los principales factores a tener en cuenta para potenciar la preocupación de los consumidores por la sostenibilidad alimentaria. Por tanto, empezar por orientar las campañas de información a consumidores con

menor nivel de formación y hacerlo de forma segmentada para cada edad será fundamental para formar a los consumidores de forma efectiva.

Certificar la producción y los productos obtenidos de forma sostenible, y aumentar la preocupación por la sostenibilidad en la población son aspectos claves para avanzar hacia un futuro sostenible.

CONCLUSIONS

In general, consumers associate sustainable production with organic products and, in turn, associate organic products with higher quality and health benefits. In all countries, consumers think that the food categories in which the most water can be saved throughout their production and distribution chain are those related to primary consumption, such as cereals and vegetables. This finding clearly shows that consumers do not associate food processing (eg snacks) with water consumption.

The determining factors in the sustainable attitude of consumers were the country, age and education. Consumers in more developed countries (Spain and the US) were more reluctant to pay an increase in the price for sustainable products. Consumers with a higher level of education showed greater concern for sustainability and the environment and were willing to pay a higher price for sustainable products. The same trend held true for millennials, who showed greater concern for the environment and, along with Gen X, a greater willingness to pay for sustainable products.

The logo proposed for hydroSOStainable products was positively valued, especially by the younger generations, and it was considered useful for the identification of these sustainable foods.

Consumer awareness is key to achieving sustainability. Consumers have not yet internalized environmental sustainability. Sustainability is understood differently in the different countries studied and depending on the food category. Low-educated consumers and the older generations are less sensitive to sustainability and the issues that arise from it. Income level, while key in some food categories, is not indicative of consumer awareness of sustainability. Gender does not affect the perception of sustainability. Consequently, segmenting training campaigns according to the group they are aimed at will provide a greater impact.

In general, it can be seen how educational level and age are the main factors to take into account to enhance consumer concern for food sustainability. Therefore, starting by targeting information campaigns to consumers with a lower level of training and segmented for each age will be essential to achieve a sustainable future.

INVESTIGACIONES FUTURAS

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INVESTIGACIONES FUTURAS

En base a los resultados obtenidos en esta Tesis Doctoral será posible continuar y desarrollar índices de riego y calidad hidroSOS para una amplia variedad de cultivos (pistachos, almendras, etc.) que fomentarán un futuro sostenible a nivel medioambiental y proporcionarán competitividad a los agricultores. Asimismo, disponer de un mayor número de cultivos con etiqueta "hidroSOS" ampliarán la información disponible a los consumidores para basar su decisión de compra en aspectos de calidad y sostenibilidad.

Otro aspecto a considerar será la formación a los agricultores, consumidores (de forma segmentada de acuerdo a su sensibilidad sobre sostenibilidad) y empresas, lo que permitirá sentar las bases para el desarrollo y la implementación de acciones formativas.

ANEXOS

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ANEXO I

ESTUDIOS DE CONSUMIDORES: ENCUESTA *ON-LINE*, REALIZADAS A TRAVÉS DE LA PLATAFORMA QUALTRICS (PROVO, UT, EE.UU.)

Sostenibilidad general

Disposición a pagar por diferentes categorías de alimentos

Múltiples aspectos de la sostenibilidad de las categorías de alimentos

Sostenibilidad del agua en categorías de alimentos

Identificación y etiquetado de productos hidroSOStenibles

QUESTIONNAIRE ON SUSTAINABILITY

DEMOGRAPHICS

1. **What is your gender?**
   - Male
   - Female
   - Choose not to answer
2. **What is your age?**
   - Under 18 years
   - 18-23
   - 24-41
   - 42-52
   - 53-73
   - 74 or older
3. **What is the highest education level you have completed?**
   - Primary school or less
   - High school diploma
   - Associate's degree
   - Bachelor's degree
   - Graduate degree or higher
4. **How much is approximately your annual income?**
   - 25,000 US dollars or less
   - 25,001-50,000 US dollars
   - 50,001-100,000 US dollars
   - 100,000 +
   - Choose not to answer
5. **We care about the quality of our survey data and hope to receive the most accurate measure of your opinion, so it is important to us that you thoughtfully provide your best answer to each question in the survey.**
   Do you commit to providing your thoughtful and honest answers to the questions in this survey?
   - I will provide my best answers
   - I will not provide my best answers
   - I can't promise either way

QUESTIONNAIRE

2. The survey that you are going to take is about FOOD and the ENVIRONMENT.
Please indicate your agreement with the following questions. We want YOUR HONEST OPINION, not what you think you should say!

2.1 A vegetarian diet can reduce greenhouse gas emissions.
2.2 Assurance of animal welfare in food production is important to me.
2.3 Consuming products made from environmentally friendly grains is more expensive than consuming conventional products.
2.4 Consuming seasonal vegetables is environmental friendly.
2.5 Conventional and highly automated farming leads to higher quality products.
2.6 Conventional fruits have the same nutrient and antioxidant content as organic fruits.
2.7 Intensive agriculture leads to reduced biodiversity which I find unacceptable.
2.8 Food/Gastronomic/Agricultural tourism can help the development and sustainability of small local farmers.
2.9 Greenhouse tomatoes have fewer nutrients because they contain more water.
2.10 I am willing to pay a slightly higher price for local foods.
2.11 The less food packaging the more sustainable the food.
2.12 I avoid buying processed food because it is not healthy.
2.13 I pay attention to environmental information on food labels.
2.14 I enjoy eating rain-fed vegetables because they are tastier than irrigated products.
2.15 I prefer buying food from local or nearby markets/producers.
2.16 I will avoid producers and products that I know have a high impact on the environment.
2.17 If the price is reasonable, I will buy foods produced using sustainable strategies.
2.18 I think cooking oils coming from plants grown with less water have a healthier fatty acid profile than conventional cooking oils.
2.19 Food produced locally is fresher than those sold in supermarkets or hypermarkets.
2.20 Local products are more nutritious than other products because they are picked riper and are fresher.
2.21 Organic foods are better used by the body because they do not have chemicals.
2.22 Organic vegetables have a nice appearance and are uniform.
2.23 Reducing land use, fresh water consumption, and fossil fuels used in food production should be an important goal of food producers.
2.24 Small farmers are essential to guarantee farming sustainability in the world.
2.25 Social aspects of food production (for example, fair trade, social right of workers) are important to me.
2.26 Sustainable agriculture must be concerned with ensuring the economic viability of the farm and the farmer.
2.27 The price I pay for organic or more sustainable foods is worth it.
2.28 The volume of water needed to grow 1 lb of tomatoes is approximately the same as the amount needed to grow 1 lb of wheat.
2.29 World food production cannot be maintained through local products; intensive agriculture is needed.
2.30 Even if the price of organic products is slightly higher than that of conventional products, I will buy the organic products.
2.31 When I choose local foods, I reduce transport and package costs.

3. Please check all those statements on <u>sustainable products</u> you agree with:

3.1. Highly sophisticated irrigation strategies are used in their production.
3.2. I accept their higher price.
3.3. I do not care too much about them.
3.4. I have never heard about sustainable food products.
3.5. I recommend their purchase to my family/friends.
3.6. Sustainable chicken tastes better because birds have the best possible nutrition.
3.7. More water is required in their production.
3.8. The price of tomatoes is the same, no matter their sustainable origin.
3.9. Their packaging is nice and labels come in bright colors.
3.10. Their price is too high for me; I will not buy them.
3.11. Their taste is similar to that of the conventional products.
3.12. There are environmental friendly.
3.13. There is a need for a logo that clearly identifies them.
3.14. There are plenty of natural resources and they will be there for a long time.
3.15. They are authentic because they ensure a proper future of agriculture.
3.16. They are healthier.
3.17. They are homogeneous in size and I like that.
3.18. They are more expensive.
3.19. They are packed using non-degradable plastics.
3.20. They are produced in a more traditional way.
3.21. I do not trust sustainable products.
3.22. They are grown or produced with fewer chemicals.
3.23. They are tastier.
3.24. They increase my trust.
3.25. They do not attract my attention.
3.26. They have a poor flavor.
3.27. They have better quality.
3.28. They look natural.

4. The next part of the survey that you are going to take is about SUSTAINABILITY of different FOOD CATEGORIES. Please indicate your agreement to the following questions.

4.1. A nice plastic packaging is essential to sell sustainable snacks.
4.2. Salt is a flavor enhancer and I am trying to double my intake of salt.
4.3. A certification proving low environmental impact will help me in eating more meat products.
4.4. Grains are always grown under rain-fed conditions, not with irrigation.
4.5. Coffee beans from extremely small farms in the mountains of Jamaica deserve a high price to be fair with the farmers and support their economic future.
4.6. Consuming farm raised fish is less sustainable than consuming sea-fish.
4.7. Beef cattle are not sustainable because they have a high carbon footprint.
4.8. Eating seafood can be risky due to the occurrence of mercury but it is so delicious that I cannot stop eating it.
4.9. Eggs from free-range hens are more sustainable than those from cage-hens.
4.10. Even though corn requires a high volume of water, I will never stop buying corn products because I like them too much.

4.11. Even though I know that confections and cakes may not good for my health, I cannot help it and still consume them often.
4.12. Extra virgin olive oil is more sustainable than canola oil because it does not go through a refining process.
4.13. Product labeled “Fair Trade” (e.g. some coffees or chocolates) are too expensive.
4.14. For sure I will buy brown sugar if labeled with high carbon and water footprint.
4.15. Green-house vegetables are widely available and are safer and more sustainable than the rain-fed ones.
4.16. Home distilled alcohols cannot be considered sustainable if risks the consumers’ health in any way.
4.17. I do not think milk quality varies much and will buy any that is on sale.
4.18. I will reduce my consumption of discretionary products (oils, sugars, alcohol) if that helps in the sustainability of the food chain.
4.19. I like to buy fair trade coffee, because this certification makes me feel good about the product source.
4.20. It is important to eat a variety of vegetables even if they are out of season.
4.21. I will not buy bottled water because it is less sustainable than tap water.
4.22. I would buy soft drinks in glass bottles if they were returnable and I will be rewarded.
4.23. If I had known that a particular food (for instance, oranges) is one of the foods producing more environmental impact, I would have reduced its consumption before.
4.24. If I could I would prefer to buy eggs directly from the farmer.
4.25. Independently of the taste, drinking bottled water is safer than drinking tap water.
4.26. It is more sustainable to drink milk than eat cheese.
4.27. It is more sustainable to eat fresh fruit than dry fruit because energy is needed to dry the products.
4.28. Organic vegetables are the perfect choice for consumers because they are bacteria-free.
4.29. Packing cupcakes individually in crystal clear bags within a bigger plastic bag is sustainable because it allows consumption of smaller portions.
4.30. Proper selection of grains with low water requirements will help to protect the environment.
4.31. If I knew that an ancient grain, such as sorghum, uses less water than wheat or corn I would want products made from that if they tasted good.
4.32. Providing consumers that have special dietary needs with proper foods is also part of the sustainability of the food chain.
4.33. Reducing the intake of animal fats can be considered as a sustainable behavior because it reduces medical expenses.
4.34. Rice-based food for people with gluten sensitivity must be sustainable to ensure the best possible quality and safety.
4.35. Seasonal fruits are the most sustainable foods; they can be eaten directly from the plant.
4.36. Sustainable snacks are those prepared using grains that optimize the use of irrigation water.
4.37. The high demand for palm oil is seriously jeopardizing the forest in countries such as Indonesia and Malaysia.
4.38. The information on labels of snack food is so much that I just buy snacks from the best-known brands.
4.39. Making yogurt at home is more sustainable that buying it from the store.
4.40. Canned-fish products are non-sustainable because they generate tons of waste.
4.41. The traceability of the milk (where the milk comes from) used in the cheese I eat is an important buying driver for me.
4.42. Traditional peach varieties are sustainable because they increase biodiversity.

4.43. Vodka is a sustainable drink because is prepared using cereal grains or potatoes.
4.44. When drinking alcoholic beverages, I do not care about their nutrition o health effects.
4.45. White sugar is less sustainable than brown sugar because a whitening process must be done.
4.46. Yogurt made with unpasteurized milk is safer than unpasteurized milk due to a sustainable fermentation process.

5. Please RANK the 7 categories of foods that you would be interested in buying, if a "more sustainable" product was available;
Rank 1 for the most interesting product and 7 for the least interesting one.

5.1. Cereal-based mixed dishes
5.2. Cereals and cereal products
5.3. Sugar and sugar products including chocolate
5.4. Fats (vegetable and animal)
5.5. Vegetable soups
5.6. Vegetables, nuts and pulses
5.7. Starchy roots and potatoes
5.8. Fruits
5.9. Fruit and vegetable juices
5.10. Soft drinks
5.11. Snack foods
5.12. Bottled water
5.13. Coffee, tea and cocoa
5.14. Beer and substitutes
5.15. Wine and substitutes
5.16. Other alcoholic beverages and substitutes
5.17. Meat and meat products and substitutes
5.18. Edible offal and offal products
5.19. Meat based preparations
5.20. Seafood and seafood products
5.21. Fish and fish products
5.22. Fish based preparations
5.23. Eggs
5.24. Milk and dairy based drinks
5.25. Dairy based products
5.26. Cheese
5.27. Miscellaneous
5.28. Food for special dietary uses
5.29. Tap water

6. **Assuming we have the same consumption of products we have today, please RANK these 11 food categories from 1 to 11 based on what you think is most likely to help in SAVING WATER (if we could change growing, production, and/or preparation).** Rank 1 for the product you think we could save the most water when growing/making, then 2 for the second, … to 11 for the one you think we could have the least impact on water use if we changed the growing/making of this.

   6.1. Grains and grains products
   6.2. Vegetables, nuts and beans
   6.3. Starchy roots and potatoes
   6.4. Fruits and juices
   6.5. Soft drinks and bottled water
   6.6. Snack foods
   6.7. Coffee, tea and cocoa
   6.8. Meat and meat products
   6.9. Fish and seafood
   6.10. Eggs
   6.11. Milk and dairy products

7. **Assuming we have the same consumption of products we have today, please CHECK which 3 categories of products <u>we should work hardest</u> to save water during growing, production, and preparation.**

   7.1. Coffee, tea and cocoa
   7.2. Eggs
   7.3. Fish and seafood
   7.4. Fruits and juices
   7.5. Grains and grains products
   7.6. Meat and meat products
   7.7. Milk and dairy products
   7.8. Snack foods
   7.9. Soft drinks and bottled water
   7.10. Starchy roots and potatoes
   7.11. Vegetables, nuts and beans

8. **Assuming products at the same liking as your current products, I am willing to pay ____ % more money for more sustainable food products (choose the proper value for each food category).**

   8.1. Cereal-based mixed dishes
   8.2. Cereals and cereal products
   8.3. Sugar and sugar products including chocolate
   8.4. Fats (vegetable and animal)
   8.5. Vegetable soups
   8.6. Vegetables, nuts and pulses
   8.7. Starchy roots and potatoes
   8.8. Fruits
   8.9. Fruit and vegetable juices

8.10. Soft drinks
8.11. Snack foods
8.12. Bottled water
8.13. Coffee, tea and cocoa
8.14. Beer and substitutes
8.15. Wine and substitutes
8.16. Other alcoholic beverages and substitutes
8.17. Meat, meat products and substitutes
8.18. Edible offal and offal products
8.19. Meat based preparations
8.20. Seafood and seafood products
8.21. Fish and fish products
8.22. Fish based preparations
8.23. Eggs
8.24. Milk and dairy based drinks
8.25. Dairy based products
8.26. Cheese
8.27. Miscellaneous
8.28. Food for special dietary uses
8.29. Tap water

9. We have developed this logo to identify water sustainable products. How much do you like the logo?

10. How easy do you think it would be to identify products as more water sustainable using this logo?

11. Please, CLICK on the area of the image that stands out most.

REFERENCIAS

9

AQUASTAT. (2016). Sistema mundial de información de la FAO sobre el agua en la agricultura. Consultada el 03 de Noviembre de 2020. http://www.fao.org/aquastat/es/overview/methodology/water-use

Azad, M. A. S., Ancev, T., y Hernández-Sancho, F. (2015). Efficient water use for sustainable irrigation industry. *Water Resources Management, 29*(5), 1683-1696. https://doi.org/10.1007/s11269-014-0904-8

Bamberg, S. (2012). Chapter 9 Understanding and promoting bicycle use–insights from psychological research'. *Cycling and Sustainability (Transport and Sustainability, Volume 1). Emerald Group Publishing Limited*, 219-246.

Baumgärtner, S., y Quaas, M. (2010). What is sustainability economics? *Ecological Economics, 69*(3), 445-450. https://doi.org/10.1016/j.ecolecon.2009.11.019

Bollani, L., Bonadonna, A., y Peira, G. (2019). The Millennials' concept of sustainability in the food sector. *Sustainability, 11*(10), 2984. https://doi.org/10.3390/su11102984

Boobalan, K., y Nachimuthu, G. S. (2020). Organic consumerism: A comparison between India and the USA. *Journal of Retailing and Consumer Services, 53*, 101988. https://doi.org/10.1016/j.jretconser.2019.101988

Bourgaud, F., Gravot, A., Milesi, S., y Gontier, E. (2001). Production of plant secondary metabolites: a historical perspective. *Plant Science, 161*(5), 839-851. https://doi.org/10.1016/S0168-9452(01)00490-3

Brenes, M., Rejano, L., García, P., Sánchez, A. H., y Garrido, A. (1995). Biochemical changes in phenolic compounds during Spanish-style green olive processing. *Journal of Agricultural and Food Chemistry, 43*(10), 2702-2706. https://doi.org/10.1021/jf00058a028

Brinkmann, J., y Peattle, K. (2008). Consumer ethics research: Reframing the debate about consumption for good. *EJBO-Electronic Journal of Business Ethics and Organization Studies*.

Brown, B. J., Hanson, M. E., Liverman, D. M., y Merideth, R. W. (1987). Global sustainability: toward definition. *Environmental management, 11*(6), 713-719.

Buerke, A., Straatmann, T., Lin-Hi, N., y Müller, K. (2017). Consumer awareness and sustainability-focused value orientation as motivating factors of responsible consumer behavior. *Review of Managerial Science, 11*(4), 959-991.

Cano-Lamadrid, M., Girón, I. F., Pleite, R., Burló, F., Corell, M., Moriana, A., y Carbonell-Barrachina, A. A. (2015). Quality attributes of table olives as affected by regulated deficit irrigation. *LWT - Food Science and Technology, 62*(1), 19-26. https://doi.org/10.1016/j.lwt.2014.12.063

Cano-Lamadrid, M., Hernández, F., Corell, M., Burló, F., Legua, P., Moriana, A., y Carbonell-Barrachina, Á. A. (2017). Antioxidant capacity, fatty acids profile, and descriptive sensory analysis of table olives as affected by deficit irrigation. *Journal of the Science of Food and Agriculture, 97*(2), 444-451. https://doi.org/10.1002/jsfa.7744

Carbonell-Barrachina, A. A., Memmi, H., Noguera-Artiaga, L., del Carmen Gijón-López, M., Ciapa, R., y Pérez-López, D. (2015). Quality attributes of pistachio nuts as affected by rootstock and deficit irrigation. *Journal of the Science of Food and Agriculture, 95*(14), 2866-2873. https://doi.org/10.1002/jsfa.7027

Cerdeño, V. J. M. (2010). Alimentos ecológicos: Oferta y demanda en España. *Distribución y consumo, 20*(112), 49-60.

Chalmers, D. J., Mitchell, P. D., y Van Heek, L. (1981). Control of peach tree growth and productivity by regulated water supply, tree density, and summer pruning. *Journal American Society for Horticultural Science, 106*, 307-312.

Cohen, M. J., y Garrett, J. L. (2010). The food price crisis and urban food (in)security. *Environment and Urbanization, 22*(2), 467-482. https://doi.org/10.1177/0956247810380375

Collado-González, J., Cruz, Z. N., Medina, S., Mellisho, C. D., Rodríguez, P., Galindo, A., Egea, I., Romojaro, F., Ferreres, F., Torrecillas, A., y Gil-Izquierdo, A. (2014). Effects of water deficit during maturation on amino acids and jujube fruit eating quality. *Macedonian Journal of Chemistry and Chemical Engineering, 33*(1), 105-119.

Collado-González, J., Moriana, A., Girón, I. F., Corell, M., Medina, S., Durand, T., Guy, A., Galano, J.-M., Valero, E., Garrigues, T., Ferreres, F., Moreno, F., Torrecillas, A., y Gil-Izquierdo, A. (2015). The phytoprostane content in green table olives is influenced by Spanish-style processing and regulated deficit irrigation. *LWT - Food Science and Technology, 64*(2), 997-1003. https://doi.org/10.1016/j.lwt.2015.07.005

Collado-González, J., Pérez-López, D., Memmi, H., Gijón, M. C., Medina, S., Durand, T., Guy, A., Galano, J. M., Fernández, D. J., Carro, F., Ferreres, F., Torrecillas, A., y Gil-Izquierdo, A. (2016). Effect of the season on the free phytoprostane content in Cornicabra extra virgin olive oil from deficit-irrigated olive trees. *Journal of the Science of Food and Agriculture, 96*(5), 1585-1592. https://doi.org/10.1002/jsfa.7259

Collins, R., Kristensen, P., Thyssen, N. (2009). Water resources across Europe-confronting water scarcity and drought. *European EnvironmentAgency, Copenhague*.

Comisión Europea. (2020). Farm to Fork Strategy - for a fair, healthy and environmentally-friendly food system. Consultada el 29 de Octubre de 2020. https://ec.europa.eu/food/farm2fork_en

Corell, M., Martín-Palomo, M. J., Sánchez-Bravo, P., Carrillo, T., Collado, J., Hernández-García, F., Girón, I., Andreu, L., Galindo, A., López-Moreno, Y. E., Centeno, A., Pérez-López, D., Carbonell-Barrachina, A. A., y Moriana, A (2019). Evaluation of growers' efforts to improve the sustainability of olive orchards: Development of the hydroSOStainable index. *Scientia Horticulturae*, 257, 108661. https://doi.org/10.1016/j.scienta.2019.108661

Curtarelli, M., y van Houten, G. (2018). Questionnaire translation in the European company survey: Conditions conducive to the effective implementation of a TRAPD-based approach. *Translation and Interpreting, 10*(2), 34-54. https://doi.org/10.12807/ti.110202.2018.a04

Darré, E., Cadenazzi, M., Mazzilli, S. R., Rosas, J. F., y Picasso, V. D. (2019). Environmental impacts on water resources from summer crops in rainfed and irrigated systems. *Journal of Environmental Management, 232*, 514-522. https://doi.org/10.1016/j.jenvman.2018.11.090

Deere, C. (1999). Eco-labelling and Sustainable Fisheries. *IUCN Publications Service*.

Dell'Amico, J., Moriana, A., Corell, M., Girón, I. F., Morales, D., Torrecillas, A., y Moreno, F. (2012). Low water stress conditions in table olive trees (*Olea europaea* L.) during pit hardening produced a different response of fruit and leaf water relations. *Agricultural Water Management, 114*, 11-17. https://doi.org/10.1016/j.agwat.2012.06.004

Ditlevsen, K., Denver, S., Christensen, T., y Lassen, J. (2020). A taste for locally produced food - Values, opinions and sociodemographic differences among 'organic' and 'conventional' consumers. *Appetite, 147*, 104544. https://doi.org/10.1016/j.appet.2019.104544

Dubé, L., Fatemi, H., Lu, J., y Hertzer, C. (2016). The healthier the tastier? USA–India comparison studies on consumer perception of a nutritious agricultural product at different food Processing Levels. *Frontiers in Public Health, 4*(6). https://doi.org/10.3389/fpubh.2016.00006

Elsevier, B. V. (2020). Scopus Database. Consultada el 15 de Octubre de 2020.

FAO. (2010). *Sustainable diets and biodiversity directions and solutions for policy, research and action*. Paper presented at the Proceedings of the International Scientific Symposium Biodiversity and Sustainable Diets United Against Hunger, Headquarters, Rome.

FAO. (2011). *The state of the world's land and water resources for food and agriculture: managing systems at risk* (O. Dubois Ed.): Earthscan, London, UK.

Feldmann, C., y Hamm, U. (2015). Consumers' perceptions and preferences for local food: A review. *Food Quality and Preference, 40*, 152-164. https://doi.org/10.1016/j.foodqual.2014.09.014

Fernandes-Silva, A. A., Falco, V., Correia, C. M., y Villalobos, F. J. (2013). Sensory analysis and volatile compounds of olive oil (cv. Cobrançosa) from different irrigation regimes. *Grasas y Aceites, 64*(1), 59-67. https://doi.org/10.3989/gya.069712

Fernández, J. E., Perez-Martin, A., Torres-Ruiz, J. M., Cuevas, M. V., Rodriguez-Dominguez, C. M., Elsayed-Farag, S., Morales-Sillero, A., García, J. M., Hernandez-Santana, V., y Diaz-Espejo, A. (2013). A regulated deficit irrigation strategy for hedgerow olive orchards with high plant density. *Plant and Soil, 372*(1), 279-295. https://doi.org/10.1007/s11104-013-1704-2

Fowler, S. J., y Hope, C. (2007). A Critical Review of Sustainable Business Indices and their Impact. *Journal of Business Ethics, 76*(3), 243-252. https://doi.org/10.1007/s10551-007-9590-2

Fransson, N., y Gärling, T. (1999). Environmental concern: Conceptual definitions, measurement methods, and research findings. *Journal of Environmental Psychology, 19*(4), 369-382.

Franzen, A., y Vogl, D. (2013). Two decades of measuring environmental attitudes: A comparative analysis of 33 countries. *Global Environmental Change, 23*(5), 1001-1008.

Fujii, S. (2006). Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. *Journal of Environmental Psychology, 26*(4), 262-268.

Galindo, A., Calín-Sánchez, Á., Griñán, I., Rodríguez, P., Cruz, Z. N., Girón, I. F., Corell, M., Martínez-Font, R., Moriana, A., Carbonell-Barrachina, A. A., Torrecillas, A., y Hernández, F. (2017). Water stress at the end of the pomegranate fruit ripening stage produces earlier harvest and improves fruit quality. *Scientia Horticulturae, 226*, 68-74. https://doi.org/10.1016/j.scienta.2017.08.029

Galindo, A., Collado-González, J., Griñán, I., Corell, M., Centeno, A., Martín-Palomo, M. J., Girón, I. F., Rodríguez, P., Cruz, Z. N., Memmi, H., Carbonell-Barrachina, A. A., Hernández, F., Torrecillas, A., Moriana, A., y López-Pérez, D. (2018). Deficit irrigation and emerging fruit crops as a strategy to save water in Mediterranean semiarid agrosystems. *Agricultural Water Management, 202*, 311-324. https://doi.org/10.1016/j.agwat.2017.08.015

García, J. M., Cuevas, M. V., y Fernández, J. E. (2013). Production and oil quality in 'Arbequina' olive (*Olea europaea* L.) trees under two deficit irrigation strategies. *Irrigation Science, 31*(3), 359-370. https://doi.org/10.1007/s00271-011-0315-z

Geerts, S., y Raes, D. (2009). Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. *Agricultural Water Management, 96*(9), 1275-1284. https://doi.org/10.1016/j.agwat.2009.04.009

Girón, I. F., Corell, M., Galindo, A., Torrecillas, E., Morales, D., Dell'Amico, J., Torrecillas, A., Moreno, F., y Moriana, A. (2015). Changes in the physiological response between leaves

and fruits during a moderate water stress in table olive trees. *Agricultural Water Management, 148*, 280-286. https://doi.org/10.1016/j.agwat.2014.10.024

Gispert-Folch, J. (2003). Evaluación del volumen de suelo húmedo en micro-irrigación. Influencia del porcentaje de este volumen sobre el comportamiento del olivo (*Olea europaea* L; cult.'Arbequina '). *Estudios de la zona no saturada del suelo, 6*, 51-58.

Gleick, P., Loh, P., Gomez, S., y Morrison, J. (1995). *California Water 2020: A Sustainable Vision*. Oakland, California.

Goldhamer, D. A. (1999) Regulated deficit irrigation for california canning olives. *Vol. 474. Acta Horticulturae* (pp. 369-372).

Gómez-Llanos, E., Durán-Barroso, P., y Robina-Ramírez, R. (2020). Analysis of consumer awareness of sustainable water consumption by the water footprint concept. *Science of The Total Environment, 721*, 137743. https://doi.org/10.1016/j.scitotenv.2020.137743

Green, H., Broun, P., Cook, D., Cooper, K., Drewnowski, A., Pollard, D., Sweeney, G., y Roulin, A. (2018). Healthy and sustainable diets for future generations. *Journal of the Science of Food and Agriculture, 98*(9), 3219-3224. https://doi.org/10.1002/jsfa.8953

Grunert, K. G. (2011). Sustainability in the food sector: A consumer behaviour perspective. *International Journal on Food System Dynamics, 2*(3), 207-218.

Harkness, J. A., van de Vijver, F. J., Mohler, P. P., y Wiley, J. (2003). *Cross-Cultural Survey Methods* (J. W. Sons Ed. Vol. 325). New York, NY: Wiley-Interscience Hoboken, NJ.

Herath, I., Green, S., Singh, R., Horne, D., van der Zijpp, S., y Clothier, B. (2013). Water footprinting of agricultural products: a hydrological assessment for the water footprint of New Zealand's wines. *Journal of Cleaner Production, 41*, 232-243. https://doi.org/10.1016/j.jclepro.2012.10.024

Hoekstra, A. Y., Chapagain, A. K., Aldaya, M. M., y Mekonnen, M. M. (2011). *The Water Footprint Assessment Manual - Setting the Global Standard* (Earthscan Ed.). London, UK.

Hooper, L., y Cassidy, A. (2006). A review of the health care potential of bioactive compounds. *Journal of the Science of Food and Agriculture, 86*(12), 1805-1813. https://doi.org/10.1002/jsfa.2599

IFIC, International Food Information Council Foundation. (2018). One-third of Americans are dieting, including one in 10 who fast … while consumers also hunger for organic, "natural" and sustainable. Consultada el 21 de Febrero de 2020. https://foodinsight.org/

Inglehart, R. (2020). *Modernization and postmodernization: Cultural, Economic, And Political Change in 43 Societies*: Princeton university press.

Iniesta, F., Testi, L., Orgaz, F., y Villalobos, F. J. (2009). The effects of regulated and continuous deficit irrigation on the water use, growth and yield of olive trees. *European Journal of Agronomy, 30*(4), 258-265. https://doi.org/10.1016/j.eja.2008.12.004

Institute of Organic Agriculture FiBL., e IFOAM, Organics International. (2019). *The World of Organic Agriculture. Statistics and Emerging Trends 2019* (H. Willer & J. Lernoud Eds.). BIOFACH.

ISO 12966-2: 2017. Animal and vegetable fats and oils - Gas chromatography of fatty acid methyl esters - Part 2: Preparation of methyl esters of fatty acids. (2017).

ISO-12966-4:2015. Animal and vegetable fats and oils - Gas chromatography of fatty acid methyl esters - Part 4: Determination by capillary gas chromatography. (2015).

Jeswani, H. K., Burkinshaw, R., y Azapagic, A. (2015). Environmental sustainability issues in the food–energy–water nexus: Breakfast cereals and snacks. *Sustainable Production and Consumption, 2*, 17-28. https://doi.org/10.1016/j.spc.2015.08.001

Khan, S., Tariq, R., Yuanlai, C., y Blackwell, J. (2004). *Can irrigation be sustainable?" New directions for a diverse planet.* Paper presented at the Proceedings of the 4th International Crop Science Congress.

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Global Environmental Change, 23*(5), 1028-1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014

Kuhlman, T., y Farrington, J. (2010). What is sustainability? *Sustainability, 2*(11), 3436-3448.

Kumar, B., Manrai, A. K., y Manrai, L. A. (2017). Purchasing behaviour for environmentally sustainable products: A conceptual framework and empirical study. *Journal of Retailing and Consumer Services, 34*, 1-9.

Leach, A. M., Emery, K. A., Gephart, J., Davis, K. F., Erisman, J. W., Leip, A., Pace, M. L., D'Odorico, P., Carr, J., Noll, L. C., Castner, E., y Galloway, J. N. (2016). Environmental impact food labels combining carbon, nitrogen, and water footprints. *Food Policy, 61*, 213-223. https://doi.org/10.1016/j.foodpol.2016.03.006

Lipan, L., García-Tejero, I. F., Gutiérrez-Gordillo, S., Demirbaş, N., Sendra, E., Hernández, F., Durán-Zuazo, V. H., y Carbonell-Barrachina, A. A. (2020). Enhancing nut quality parameters and sensory profiles in three almond cultivars by different irrigation regimes. *Journal of Agricultural and Food Chemistry*. https://doi.org/10.1021/acs.jafc.9b06854

Lipan, L., Martín-Palomo, M. J., Sánchez-Rodríguez, L., Cano-Lamadrid, M., Sendra, E., Hernández, F., Burló, F., Vázquez-Araújo, L., Andreu, L., y Carbonell-Barrachina, Á. A. (2019). Almond fruit quality can be improved by means of deficit irrigation strategies.

Agricultural Water Management, 217, 236-242. https://doi.org/10.1016/j.agwat.2019.02.041

Lorite, I. J., García-Vila, M., Carmona, M.-A., Santos, C., y Soriano, M.-A. (2012). Assessment of the irrigation advisory services' recommendations and farmers' irrigation management: A case study in southern Spain. *Water Resources Management, 26*(8), 2397-2419. https://doi.org/10.1007/s11269-012-0023-3

Malheiro, R., Mendes, P., Fernandes, F., Rodrigues, N., Bento, A., y Pereira, J. A. (2014). Bioactivity and phenolic composition from natural fermented table olives. *Food and Function, 5*(12), 3132-3142. https://doi.org/10.1039/c4fo00560k

Malochleb, M. (2018). Sustainability: How food companies are turning over a new leaf. *Food Technology Magazine, 72,* 32-43.

McLaughlin, D., y Kinzelbach, W. (2015). Food security and sustainable resource management. *Water Resources Research, 51*(7), 4966-4985. https://doi.org/10.1002/2015wr017053

Meyer-Höfer, M. v. (2014). *Product Differentiation and Consumer Preferences for Sustainable Food.* Georg-August-Universität Göttingen, Göttingen.

Meyer, R., y Liebe, U. (2010). Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in Switzerland. *Population and Environment, 32*(1), 42-65.

Moore, J. E., Mascarenhas, A., Bain, J., y Straus, S. E. (2017). Developing a comprehensive definition of sustainability. *Implementation Science, 12*(1), 110. https://doi.org/10.1186/s13012-017-0637-1

Moriana, A., Corell, M., Girón, I. F., Conejero, W., Morales, D., Torrecillas, A., y Moreno, F. (2013). Regulated deficit irrigation based on threshold values of trunk diameter fluctuation indicators in table olive trees. *Scientia Horticulturae, 164*, 102-111. https://doi.org/10.1016/j.scienta.2013.09.029

Moriana, A., Orgaz, F., Pastor, M., y Fereres, E. (2003). Yield responses of a mature olive orchard to water deficits. *Journal of the American Society for Horticultural Science, 128*(3), 425-431.

Moriana, A., Pérez-López, D., Gómez-Rico, A., Salvador, M. d. l. D., Olmedilla, N., Ribas, F., y Fregapane, G. (2007). Irrigation scheduling for traditional, low-density olive orchards: Water relations and influence on oil characteristics. *Agricultural Water Management, 87*(2), 171-179. https://doi.org/10.1016/j.agwat.2006.06.017

Naciones Unidas. (2012). *The future we want*. Paper presented at the Rio+20 United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil. https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf

Naciones Unidas. (2015). *Memoria del Secretario general sobre la labor de la Organización.* New York.

Naciones Unidas. (2020). Objetivos de Desarrollo Sostenbile. Consultada el 21 September 2020. https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/

Noguera-Artiaga, L., Lipan, L., Vázquez-Araújo, L., Barber, X., Pérez-López, D., y Carbonell-Barrachina, Á. A. (2016). Opinion of Spanish consumers on hydrosustainable pistachios. *Journal of Food Science, 81*(10), S2559-S2565. https://doi.org/10.1111/1750-3841.13501

Noguera-Artiaga, L., Salvador, M. D., Fregapane, G., Collado-González, J., Wojdyło, A., López-Lluch, D., y Carbonell-Barrachina, Á. A. (2019). Functional and sensory properties of pistachio nuts as affected by cultivar. *Journal of the Science of Food and Agriculture, 99*(15), 6696-6705. https://doi.org/10.1002/jsfa.9951

Noguera-Artiaga, L., Sánchez-Bravo, P., Hernández, F., Burgos-Hernández, A., Pérez-López, D., y Carbonell-Barrachina, Á. A. (2020). Influence of regulated deficit irrigation and rootstock on the functional, nutritional and sensory quality of pistachio nuts. *Scientia Horticulturae, 261*, 108994. https://doi.org/10.1016/j.scienta.2019.108994

Noguera-Artiaga, L., Sánchez-Bravo, P., Pérez-López, D., Szumny, A., Calin-Sánchez, Á., Burgos-Hernández, A., y Carbonell-Barrachina, Á. A. (2020). Volatile, sensory and functional properties of hydroSOS pistachios. *Foods, 9*(2), 158. https://doi.org/10.3390/foods9020158

ONU, Organización de la Naciones Unidas. (1987). *Nuestro futuro común. Informe de la comisión mundial sobre el medio ambiente y el desarrollo.* Oxford; New York: Oxford University Press.

Ozdemir, Y. (2016). Effects of climate change on olive cultivation and table olive and olive oil quality. *Horticulture, LX*, 65-69.

Paavola, J. (2001). Towards sustainable consumption: economics and ethical concerns for the environment in consumer choices. *Review of Social Economy, 59*(2), 227-248.

Paloviita, A. (2010). Consumers' sustainability perceptions of the supply chain of locally produced food. *Sustainability, 2*(6), 1492-1509.

Pastor, M. (1989). Efecto del no-laboreo en olivar sobre la infiltración de agua en el suelo. *Investigación agraria. Producción y protección vegetales, 4*(2), 225-247.

Pastor, M., Castro, J., Humanes, M., y Muñoz, J. (2001). Sistemas de manejo del suelo en olivar de Andalucía. *Edafología, 8*, 75-98.

Phipps, M., Ozanne, L. K., Luchs, M. G., Subrahmanyan, S., Kapitan, S., Catlin, J. R., Gau, R., Naylor, R. W., Rose, R. L., y Simpson, B. (2013). Understanding the inherent complexity

of sustainable consumption: A social cognitive framework. *Journal of Business Research, 66*(8), 1227-1234.

Pierantozzi, P. (2012). Aplicación de distintos niveles de estrés hídrico durante el periodo prefloración-floración del olivo (*Olea europaea* L.): influencia sobre parámetros agronómicos, bioquímico-fisiológicos y productivos.

PNUMA, Programa de las Naciones Unidas para el Medio Ambiente. (2011). Paving the Way for Sustainable Consumption and Production the Marrakech Process Progress Report. Consultada el 30 de Julio de 2020. https://sustainabledevelopment.un.org/content/documents/947Paving_the_way_final.pdf

Poore, J., y Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science, 360*(6392), 987-992. https://doi.org/10.1126/science.aaq0216

Popa, M. E., Mitelut, A. C., Popa, E. E., Stan, A., y Popa, V. I. (2019). Organic foods contribution to nutritional quality and value. *Trends in Food Science & Technology, 84*, 15-18. https://doi.org/10.1016/j.tifs.2018.01.003

Prentice, C., Chen, J., y Wang, X. (2019). The influence of product and personal attributes on organic food marketing. *Journal of Retailing and Consumer Services, 46*, 70-78. https://doi.org/10.1016/j.jretconser.2017.10.020

R299/2013. Commission implementing regulation (EU) No 299/2013 of 26 March 2013 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-residue oil and on the relevant methods of analysis. Versión consolidada.

R834/2007. Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91. Vesión consolidad 01/07/2013.

R1308/2013. Regulation (EU) No 1308/2013 of the European parliament and of the Council of 17 December 2013 establishing a common organization of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007. Versión consolidada 01/01/2019.

R2018/848. Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007. Versión consolidada 14/06/2018.

Ramírez, T., Meas, Y., Dannehl, D., Schuch, I., Miranda, L., Rocksch, T., y Schmidt, U. (2015). Water and carbon footprint improvement for dried tomato value chain. *Journal of Cleaner Production, 104*, 98-108. https://doi.org/10.1016/j.jclepro.2015.05.007

Rapoport, H. F., Pérez-López, D., Hammami, S. B. M., Agüera, J., y Moriana, A. (2013). Fruit pit hardening: Physical measurement during olive fruit growth. *Annals of Applied Biology, 163*(2), 200-208. https://doi.org/10.1111/aab.12046

Rinaldi, R., Amodio, M. L., Colelli, G., Nanos, G. D., y Pliakoni, E. (2011). *Effect of deficit irrigation on fruit and oil quality of 'Konservolea' olives*.

Rodríguez, P., Galindo, A., Collado-González, J., Medina, S., Corell, M., Memmi, H., Girón, I. F., Centeno, A., Martín-Palomo, M. J., Cruz, Z. N., Carbonell-Barrachina, A., Hernández, F., Torrecillas, A., Moriana, A., y Pérez-López, D. (2018). Chapter 15 - Fruit response to water-scarcity scenarios. Water relations and biochemical changes. En *Water Scarcity and Sustainable Agriculture in Semiarid Environment,* I. F. García Tejero & V. H. Durán Zuazo (Eds.), (pp. 349-375): Academic Press.

Roser, M., Ritchie, H., y Ortiz-Ospina, E. (2015). Internet. *Our World in Data*. https://ourworldindata.org/internet

S&P Dow Jones Indices. (2020). Dow Jones Sustainability World Indicex. Consultada el 03 de Noviembre de 2020. https://espanol.spindices.com/indices/equity/dow-jones-sustainability-world-index

Sakouhi, F., Harrabi, S., Absalon, C., Sbei, K., Boukhchina, S., y Kallel, H. (2008). α-Tocopherol and fatty acids contents of some Tunisian table olives (*Olea europea* L.): Changes in their composition during ripening and processing. *Food Chemistry, 108*(3), 833-839. https://doi.org/10.1016/j.foodchem.2007.11.043

Sánchez-Bravo, P., Collado-González, J., Corell, M., Noguera-Artiaga, L., Galindo, A., Sendra, E., Hernández, F., Martín-Palomo, M. J., y Carbonell-Barrachina, Á. A (2020). Criteria for HydroSOS Quality Index. Application to Extra Virgin Olive Oil and Processed Table Olives. *Water*, 12(2), 555. https://doi.org/10.3390/w12020555

Sánchez-Rodríguez, L., Lipan, L., Andreu, L., Martín-Palomo, M. J., Carbonell-Barrachina, Á. A., Hernández, F., y Sendra, E. (2019). Effect of regulated deficit irrigation on the quality of raw and table olives. *Agricultural Water Management, 221*, 415-421. https://doi.org/10.1016/j.agwat.2019.05.014

Sánchez Gómez, A. H., García García, P., y Rejano Navarro, L. (2006). Elaboration of table olives. *Grasas y Aceites, 57*(1), 86-94. https://doi.org/10.3989/gya.2006.v57.i1.24

Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology, 10*(1), 221-279.

Seattle Department of Construction and Inspections. (2019). Seattle green factor Consultada el February 2019. http://www.seattle.gov/sdci/codes/codes-we-enforce-(a-z)/seattle-green-factor

Seninde, D. R., y Chambers IV, E. (2020). Comparing four question formats in five languages for on-line consumer surveys. *Methods and Protocols, 3*(3), 49.

Shackel, K. (2018). The pressure chamber in prunes. Fruit and nut research and information center. Consultada el 01 de Septiembre de 2020. http://fruitsandnuts.ucdavis.edu/pressure_chamber_prunes/

Siegrist, M., y Hartmann, C. (2019). Impact of sustainability perception on consumption of organic meat and meat substitutes. *Appetite, 132*, 196-202.

Siegrist, M., Visschers, V. H., y Hartmann, C. (2015). Factors influencing changes in sustainability perception of various food behaviors: Results of a longitudinal study. *Food Quality and Preference, 46*, 33-39.

Springmann, M., Godfray, H. C. J., Rayner, M., y Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. *Proceedings of the National Academy of Sciences, 113*(15), 4146-4151. https://doi.org/10.1073/pnas.1523119113

Steenis, N. D., van Herpen, E., van der Lans, I. A., Ligthart, T. N., y van Trijp, H. C. (2017). Consumer response to packaging design: The role of packaging materials and graphics in sustainability perceptions and product evaluations. *Journal of Cleaner Production, 162*, 286-298.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., y Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science, 347*(6223), 1259855. https://doi.org/10.1126/science.1259855

Stern, P. C. (2000). New environmental theories: toward a coherent theory of environmentally significant behavior. *Journal of social issues, 56*(3), 407-424.

Stern, P. C., y Dietz, T. (1994). The value basis of environmental concern. *Journal of Social Issues, 50*(3), 65-84.

SWNZ. (2017). sustainable Winegrowing NZ. Consultada el 01 de Septiembre de 2020. http://www.nzwine.com/sustainability/sustainable-winegrowing-new-zealand/

Tilman, D., y Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature, 515*(7528), 518-522. https://doi.org/10.1038/nature13959

Tovar, M. J., Motilva, M. J., y Romero, M. P. (2001). Changes in the phenolic composition of virgin olive oil from young trees (*Olea europaea* L. cv. Arbequina) grown under linear irrigation strategies. *Journal of Agricultural and Food Chemistry, 49*(11), 5502-5508. https://doi.org/10.1021/jf0102416

Urbina-Vallejo, J. (1990). La calidad de los frutos. *Revista de Fruticultura, 5(2),* 120-127.

Vanham, D., y Bidoglio, G. (2013). A review on the indicator water footprint for the EU28. *Ecological Indicators, 26*, 61-75. https://doi.org/10.1016/j.ecolind.2012.10.021

Verain, M. C., Sijtsema, S. J., y Antonides, G. (2016). Consumer segmentation based on food-category attribute importance: The relation with healthiness and sustainability perceptions. *Food Quality and Preference, 48*, 99-106.

Villalobos, F. J., y Fereres, E. (2016). Agriculture and Agricultural Systems. En F. J. Villalobos & E. Fereres (Eds.), *Principles of Agronomy for Sustainable Agriculture* (pp. 1-12). Berlin, Germany: Springer, Cham.

Wessells, C. R., Cochrane, K., Deere, C., Wallis, P., y Willmann, R. (2001). Ecolabelling. En FAO (Ed.), *Product Certification and Ecolabelling for Fisheries Sustainability*. Rome, Italy.

Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., Ezeh, A., Frumkin, H., Gong, P., Head, P., Horton, R., Mace, G. M., Marten, R., Myers, S. S., Nishtar, S., Osofsky, S. A., Pattanayak, S. K., Pongsiri, M. J., Romanelli, C., Soucat, A., Vega, J., y Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation Lancet Commission on planetary health. *The Lancet, 386*(10007), 1973-2028. https://doi.org/10.1016/S0140-6736(15)60901-1

Wichelns, D., y Oster, J. D. (2006). Sustainable irrigation is necessary and achievable, but direct costs and environmental impacts can be substantial. *Agricultural Water Management, 86*(1), 114-127. https://doi.org/10.1016/j.agwat.2006.07.014

Wilke, H. A. (1991). Greed, efficiency and fairness in resource management situations. *European Review of Social Psychology, 2*(1), 165-187.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S. E., Srinath Reddy, K., Narain, S., Nishtar, S., y Murray, C. J. L. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447-492. https://doi.org/10.1016/S0140-6736(18)31788-4

Zsóka, Á., Szerényi, Z. M., Széchy, A., y Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. *Journal of Cleaner Production, 48*, 126-138.