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Modelling perceived quality of tomato by structural equation analysis

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Abstract

Purpose – This paper aims to further progress in research on perceived quality of fresh fruit and vegetables. It seeks to develop and discuss two models for perceived quality of tomato, including the price variable as an indicator for perceived quality of tomato.

Design/methodology/approach – The data come from a survey of 400 consumers that measures the importance of a set of tomato attributes on a Likert scale. The models were adjusted by means of structural equation analysis. Two procedures were followed for model development: the first started from an exploratory factor analysis. In the second, relations and correlations among variables were established starting from the theoretical framework that differentiates among search, experience and credence attributes.

Findings – Two models of tomato perceived quality are formulated and discussed. Both established that the perceived quality of fresh tomato could be explained through nine attributes. Some of them can be deduced at the place of purchase; some, during consumption while others are a question of trust. With regard to using price as an indicator of the perceived quality of tomato, both models suggested the elimination of this variable from the model for perceived quality.

Originality/value – Studying perceived quality has received much attention in research on the behaviour of food consumers. Nevertheless, there are not many attempts to establish models for the perceived quality of fresh fruit and vegetables. Specifically, there are very few studies on consumer behaviour that analyse the perceived quality of tomato. Thus, this study is one of the first attempts to establish a model for perceived quality of tomato.

Keywords Structural equation models, Search attributes, Experience attributes, Credence attributes, Perceived quality, Fruits, Vegetables, Quality, Food products, Sensory perception

Paper type Research paper

1. Introduction

1.1 Perceived quality in studies on food consumer behaviour

Studying perceived quality has received much attention in research on the behaviour of food consumers. Perceived or subjective quality is defined as “the judgement a consumer makes about the superiority or excellence of a product” (Zeithaml, 1988). It is



differentiated from objective quality, which refers to the physical characteristics of the product, and is related more to engineering and food technology. It is of vital importance to food producers that consumer desires be expressed as physical characteristics of the products (Grunert, 2005). Likewise, it is the competence of researchers on food consumer behaviour to find models for perceived quality that explain how consumers make subjective judgements about food quality and on what attributes, cues or indicators they base these judgements.

In short, while the approach followed by food sciences, including technology, is based on the concept of objective quality, the focus on consumer behaviour is based on the paradigm of perceived quality. The objective characteristics of the product are not the centre of interest. Rather, what is of interest are its subjectively perceived product attributes (Becker, 2000).

Within this paradigm four approaches are differentiated to explain perceived quality (Ness *et al.*, 2010; Grunert, 1997). The first one provides the framework for this research.

The information economy approach differentiates between search, experience and credence attributes (Nelson, 1970; Darby and Karni, 1973). Search attributes are the ones that can be verified prior to purchase or consumption through direct inspection or readily available sources, for example, prices or brand names. In experience goods this information cannot be determined until trying or using the product. For a food product, taste is typically an experience characteristic, unless tasting is allowed before the purchase (Grunert, 1997). Last, the relevant information on credence attributes cannot be confirmed even after using the product. Desirable product benefits like nutritional value and wholesomeness cannot be directly experienced. One has to rely on the judgment or information of others that the product contains a determined quality attribute. Environmental quality of products, health or animal friendly processes are examples of typical credence quality attributes since they deal with a question of trust (Oude and Van Trijp, 1995). Although there is a more or less generalised consensus about the differentiation among these three types of goods, including various attributes in one category or another is not that clear. This approach has been used as a framework for numerous studies on food quality (Ragaert *et al.*, 2004; Verbeke *et al.*, 2007) as well as other products and services (Parasuraman *et al.*, 1985).

Other approaches are the multidimensional which conceives quality as a multidimensional phenomenon and is based on the dichotomy between intrinsic and extrinsic cues (Olson and Jacoby, 1972; Zeithaml, 1988); the means-ends chain approach that arises from a hierarchy that links product attributes to the consequences of consumption and the latter to life values (Grunert, 1995); and the integrated approach, as its name indicates, represents an attempt to integrate the various approaches into a single one, the Total Food Quality Model developed by Grunert *et al.* (1996) which differentiates between pre-purchase and post-purchase components.

Regarding research applied to perceived quality models in food, one of the most extended studies was for the meat sector, perhaps due to the frequent crises of confidence that have affected this sector (Grunert, 1997; Becker, 2000; Bredahl, 2003; Grunert *et al.*, 2004; Banovic *et al.*, 2009). Even so, in the literature it is also possible to find studies on the perceived quality of other products such as home-made ice cream (Bower and Baxter, 2000), red wine (Verdú *et al.*, 2004) and packaged, minimally processed fruit and vegetables (Ragaert *et al.*, 2004). Nevertheless, there are not many

attempts to establish models for the perceived quality of fresh fruit and vegetables. The perishable characteristic of these products, their seasonality, diversity, and absence of recognised promotional brands are some of the characteristics that make the establishment of general quality models difficult. We emphasise the work done by Sulé *et al.* (2002) where, based on the distinction between extrinsic and intrinsic attributes made by Olson and Jacoby (1972), they established a model for the perceived quality of fruit.

1.2 Perceived quality cues or indicators

When researching perceived quality, it is convenient to take into account the distinction made by Becker (2000) between product characteristics and attributes. The word characteristics is used principally in food science literature, while the word attribute is more often used in consumer behaviour literature, however, they are often used indiscriminately. When focusing on product characteristics, technical indicators are used to measure product quality, while when focusing on product attributes, the consumer uses cues to evaluate product performance depending on their needs.

In scientific literature many papers are found that analyse the quality of tomato from a technical viewpoint where characteristics such as calibre, texture, juiciness and acidity are measured. However, there are very few studies on consumer behaviour that analyse the perceived quality of tomato. Van den Heuvel *et al.* (2007) identify several quality cues for tomatoes in a literature review and a series of in-depth interviews. Besides, from the review of articles that measure objective quality in tomato (Johansson *et al.*, 1999; Jahns *et al.*, 2001; Azodanloua *et al.*, 2003; Flores *et al.*, 2010) and articles that measure the perceived quality of fresh fruit and vegetables (Sulé *et al.*, 2002), it is possible to select a series of tomato attributes of importance during purchase. These attributes can be classified into intrinsic-extrinsic indicators and search-experience-credence quality as is shown on Table I (adapted from Becker, 2000).

The inclusion of various attributes in the different categories is not conclusive. For example, aroma or firmness can be evaluated before purchase if the establishment allows the fruit to be touched. This is not always possible, in which case they would become experience attributes. The variety, origin or guarantee label can be search attributes in principle, but they are also credence attributes in the sense that consumers cannot verify the veracity of that information by themselves. Others such as price, brand name, colour, size and external damage are clearly indicators that can be confirmed during purchase.

Price has always been surrounded by controversy when establishing quality indicators in a model. There are many studies that have researched the relationship between price and quality, with little consensus on its magnitude or statistical significance (Rao and Monroe, 1989). The evolution of these studies has gone from

Table I.
Classification of
attributes for the
purchase of fresh tomato

	Intrinsic attributes	Extrinsic attributes
Search quality	Colour, size Variety, aroma, firmness	Price, brand, external damage, origin, guarantee label
Experience quality	Flavour, aroma, firmness	
Credence quality	Variety	Origin, guarantee label

traditional papers that only consider the effect of price on consumer perceived quality (Peterson, 1970; Hjorth-Andersen, 1984) to current ones that include other intrinsic and extrinsic cues (Bredahl, 2003). According to Zeithaml (1988), consumers use price to infer quality when it is the only available cue, but when there are other cues, the price-quality relationship is less convincing. This same author points out that the use of price as a quality indicator depends on: the availability of other quality cues, the variation of prices within a class of products, variation in quality throughout a category of products, level of importance of price to the consumer and consumer ability to detect variations in quality in a group of products. The conclusions of researchers in this sense are quite diverse (Bredahl, 2003): the use of price as a quality cue decreases as familiarity with the product increases and increases in unbranded products or when consumer motivation is low.

From this review, the objective to advance in the study of the perceived quality of fresh fruit and vegetables was proposed through the development of a model that can explain the perceived quality of fresh tomato. This research was based on the information economy approach and on the differentiation among search, experience and credence attributes. The following specific aims were posed:

- to develop an experimental model for the perceived quality of tomato starting from an exploratory factor analysis;
- to develop a model for the perceived quality of tomato starting from the classification among search, experience and credence attributes; and
- to analyse the importance of price as a quality indicator for fresh tomato.

2. Methodology

2.1 Data collection

Data was obtained through a survey of 400 tomato purchasers in the province of Alicante during the month of June, 2008.

In the survey participants were asked to indicate the importance they conceded to a series of tomato attributes on a five-level adapted Likert-type scale (1: hardly important; 5: very important). The attributes under consideration were aroma, price, size, guarantee label, origin, variety, external damage, flavour, brand, colour and firmness.

The surveys were taken on the street by two properly trained interviewers told to survey tomato buyers only. So, the first question on the survey was a filter that discarded possible consumers but not buyers. The questionnaire also contained questions about the socio-demographical characteristics of the participants and other sections that do not concern this paper. The time it took to complete each survey was an average of about ten minutes. The technical card for the survey can be seen in Table II.

Population	Tomato purchasers
Geographical scope	Alicante (South East of Spain)
Sample size	400
Sampling type	Stratified random by age and type of habitat
Date of collecting data	June 2008

Table II.
Technical card of the
survey

Structural equation analysis was used to analyse the data. This permits forming econometric structural equation models that explicitly incorporate the psychometric notion of unobservable variables (constructs) and measurement error (Fornell and Larcker, 1981). Their main advantage is that they allow simultaneous examination of various relations among dependent and independent variables: dependence relations among variables, the same as a regression analysis would and the representation of a concept through several observed variables, similar to a factor analysis.

Its basis lies in the comparison of the variance and covariance matrix of the model specified by the researcher to the variance and covariance matrix of the sample under study. That is to say, the one that represents the internal structure of the variables, which make up the database (Diez, 1992). The more similar these two matrices are, the better the specified model is, since it means that the model reproduces the system of relations existing in reality.

A structural equations model has two components: the structural model and the measurement model. The former represents relationships among constructs and the latter, relationships between each construct or latent variable, and the observed variables.

To develop a causal model, relations and correlations among variables can be directly specified either departing from theoretical justifications or from an exploratory factor analysis (EFA) to determine which observable variables load on which latent variables. Those loads are then backed up through a confirmatory factor analysis (CFA). The second case is an experimental model.

This paper proceeds in both ways: proposing a causal model based directly on theoretical justifications and constructing an experimental model based on a EFA.

The structural equation models were estimated using Amos v. 19.0. To assess the goodness-of-fit of the model, first we analyse the factor loadings that relate each indicator to the constructs. When the Critical Ratio (CR) is > 1.96 for a regression weight, that path is significant at the 0.05 level (that is, its estimated path parameter is significant).

Second, we examined the goodness-of-fit tests. The absolute fit measures determine the degree to which the overall model predicts the observed covariance or correlation matrix (Hair *et al.*, 1999). We decided not to use the Chi-square measure because of the well-known problems associated with large sample sizes (Browne and Cudeck, 1993). Instead, we reported the CMIN/DF, which is less sensible to sample size. According to Amos User's Guide the ratio should be close to one for correct models. The trouble is that it isn't clear how far from one you should let the ratio get before concluding that a model is unsatisfactory. According to Carmines and McIver (1981) the range of 2 to 1 or 3 to 1 are indicative of an acceptable fit between the hypothetical model and the sample data. In addition, the goodness-of-fit index (GFI) and the adjusted goodness-of-fit (AGFI) are reported. Both should have values as close to 1 as possible. Besides, the root mean square error of approximation (RMSEA) is reported. It is generally agreed that values below 0.05 indicate a close fit, while values of up to 0.08 are also acceptable (Browne and Cudeck, 1993). Regarding incremental fit measures, which compare the default model with the null model, NFI and CFI are reported. It is generally agreed that values above 0.9 indicates a good fit.

Finally, with the aim of achieving a better fit of the model, we have used the modification indices. Amos computes a modification index for each parameter that is explicitly constrained, for parameters that are implicitly assumed to be zero and for paths that do not appear in a model. The modification index for a parameter or absent path is an estimate of the amount by which the discrepancy function would decrease if the analysis were repeated with the constraints on that parameter removed or if such a path were introduced. Modification indices are often used to alter models to achieve better fit, but this must be done carefully and arrows should be added only when the relationship makes theoretical sense.

3. Results

3.1 Socio-demographic profile of the sample

First, the descriptive characteristics of the surveyed sample are shown (Table III).

As is seen, the number of surveyed women is considerably higher than of men. This can be explained because, as mentioned above, only regular tomato buyers were

Variable	Category	%
Gender	Female	71.8
	Male	28.2
Age (years-old)	18-24	13.2
	25-34	14.4
	35-49	28.8
	50-64	25.8
	> 64	17.8
Education level	Primary	38.6
	Secondary	33.8
	University	27.8
Monthly family income (€)	< 600	7.0
	600-900	10.0
	900-1,500	36.5
	1,500-3,000	34.0
	> 3,000	12.5
Size of the habitat	< 10,000	14.0
	10,000-50,000	36.0
	> 50,000	50.0
Family size	1	11.3
	2	19.2
	3	29.0
	4	31.0
	5	6.4
	6 or more	3.1
Job activity	Housewife	16.0
	Wage-earner	40.5
	Student	9.7
	Retiree	15.0
	Businessman	8.8
	Other	10.0

Table III.
Socio-demographic
profile of the sample

surveyed. Stratification of the sample was made according to the age and size of the habitat, so that distribution by these two variables represents that of the population of Alicante. In regard to educational level, the sample distribution is quite well balanced among the three categories under consideration (primary, secondary, university). Regarding monthly family income, average incomes predominate (between 900-1500 € and between 1,500-3,000 € monthly). Referring to family size, families of three and four members predominate, although families with two members and one-person households also represent an important percentage. In regard to job activity, 40 per cent of the sample was made up of salaried workers. Housewives and retirees represented 16 and 15 per cent of the sample respectively.

3.2 Average importance of tomato attributes

Next are the descriptive results of the key question in this paper, that is, the importance given to various tomato attributes. Table IV shows the average, standard deviation, minimum and maximum of these attributes.

Flavour was the attribute having the greatest average importance (4.80) and the lowest standard deviation (0.405). Besides, the range of answers was observed to fluctuate between a minimum of three, and a maximum of five. That is, no surveyed thought that flavour had an importance of 1 or 2 on the Likert scale. After flavour, external damage (4.33) followed in average importance, then firmness (4.23), colour (3.91), price (3.88), and aroma (3.74), all having an importance near 4 and standard deviations lower than or close to one. Next were the guarantee label (3.44), variety (3.33), origin (3.2) and size (3.05). The brand had an average importance of 2.22 and was the only attribute with an importance under 3. The absence of recognised brands in the fresh tomato sector could explain the low average importance of this attribute.

3.3 Model for perceived quality based on a EFA

Next the results are shown of a EFA carried out starting from the attributes of tomato. The method of extraction was the analysis of the main components, and the rotation method was Varimax with Kaiser Normalisation. The factor analysis extracted three factors: the first factor groups together origin, guarantee label, brand and variety; the second factor groups firmness, flavour, colour and aroma and the third factor is composed of price, external damage and size. These three factors were named: Guarantee, Organoleptic Characteristics and External Attributes (Table V).

	Mean	Std dev.	Mimumum	Maximum
Flavour	4.80	0.405	3	5
External damage	4.33	0.899	1	5
Firmness	4.23	0.717	1	5
Colour	3.91	0.851	1	5
Price	3.88	0.960	1	5
Aroma	3.74	1.071	1	5
Guarantee label	3.44	1.329	1	5
Variety	3.33	1.109	1	5
Origin	3.20	1.272	1	5
Size	3.05	1.067	1	5
Brand	2.22	1.111	1	5

Table IV.
Descriptive statistics of
tomato attributes

	1	Factor 2	3
Origin	0.786	0.062	-0.021
Guarantee label	0.721	0.029	-0.004
Brand	0.609	0.074	0.007
Variety	0.600	0.295	0.077
Firmness	0.079	0.707	0.059
Flavour	0.043	0.665	0.046
Colour	0.196	0.579	0.235
Aroma	0.215	0.412	-0.344
Price	-0.032	-0.122	0.746
External damage	-0.076	0.362	0.587
Size	0.203	0.207	0.545

Table V.
Factor analysis of the
attributes of tomato

Starting from this EFA, the following structural equations model was proposed where the perceived quality would be a theoretical construct explained by three latent variables: Guarantee, Organoleptic Characteristics and External Factors. Each one is explained by the observable variables most correlated to the factor that they represent (Figure 1).

Figure 2 shows Model 1a, the observable variables that form each construct, as well as the errors of measurement that accompany each variable. In this figure the observable variables are represented by rectangles and the latent variables by ovals. The arrows that connect latent variables to explicative variables give us an idea of the variables that each construct measures. Likewise, the correlations established among measurement errors are shown.

Standardised regression weights as well as model fit can be seen on Tables VI and VII respectively. All the observable variables are significant at a level of significance of 0.05 except the brand and price, which are significant at a level of significance of 0.10. Correlations among measurement errors were established by following the indications of the modification indices suggested for the programme to improve model fit when justified.

Variety, followed by origin, was the observable variable that contributed the most toward explaining the Guarantee construct. The guarantee label and the brand had less weight. In regard to Organoleptic Characteristics, the variables having greater weight

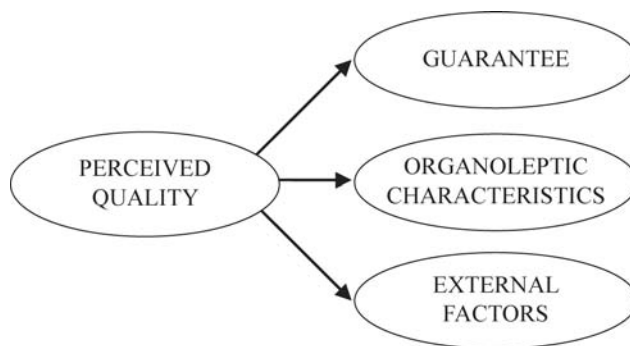


Figure 1.
Latent variables proposed
for measuring perceived
quality of tomato

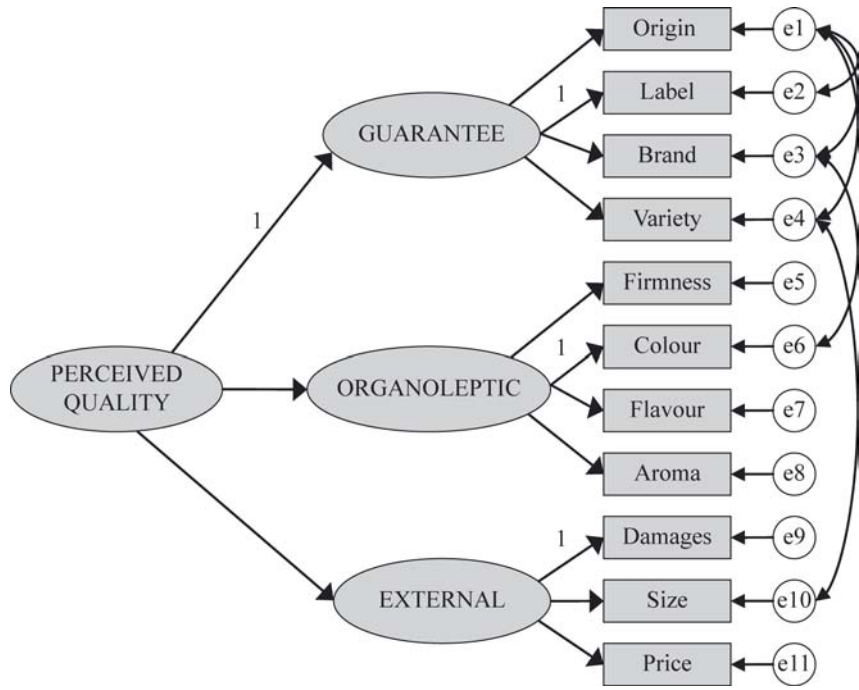


Figure 2.
Model 1a for perceived quality of tomato

ORGANOLEPTIC	< -	PERCQUAL	1.000
GUARANTEE	< -	PERCQUAL	0.596
EXTERNAL	< -	PERCQUAL	0.530
Variety	< -	GUARANTEE	0.660
Origin	< -	GUARANTEE	0.440
Guarantee label	< -	GUARANTEE	0.360
Brand	< -	GUARANTEE	0.319
Firmness	< -	ORGANOLEPTIC	0.565
Colour	< -	ORGANOLEPTIC	0.560
Flavour	< -	ORGANOLEPTIC	0.449
Aroma	< -	ORGANOLEPTIC	0.238
Damages	< -	EXTERNAL	0.570
Size	< -	EXTERNAL	0.435
Price	< -	EXTERNAL	0.289

Table VI.
Standardized regression weights. Model 1a

	CMIN/DF	GFI	AGFI	NFI	CFI	RMSEA
Default model	1.666	0.974	0.953	0.882	0.947	0.041
Saturated model		1.000		1.000	1.000	
Independence model	9.211	0.764	0.716	0.000	0.000	0.143
Optimum values	1-3	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08

Table VII.
Summary of measures of fit for model 1a

were firmness and colour followed by flavour. Aroma had less relative weight. Last, the External Factors construct was explained to a greater extent by external damage and the size of the fruit, and to a lesser extent by the price.

Regarding model goodness-of-fit, all indices were found within optimum values except incremental fit indices (NFI and CFI), which showed somewhat adjusted values, especially the NFI. The more they approach 1, the better they are.

With the purpose of improving fit, omitting the brand and price variables was given a try in the following model. They were not significant at a level of 0.05 and besides they were the ones having the least relative weight in their respective constructs. The resultant model (1b) is shown in Figure 3.

The standardised regression weights appear on Table VIII. They hardly modified the influence of the observable variables in their respective constructs.

On the contrary, model fit improved considerably. All indices were within optimum values (Table IX).

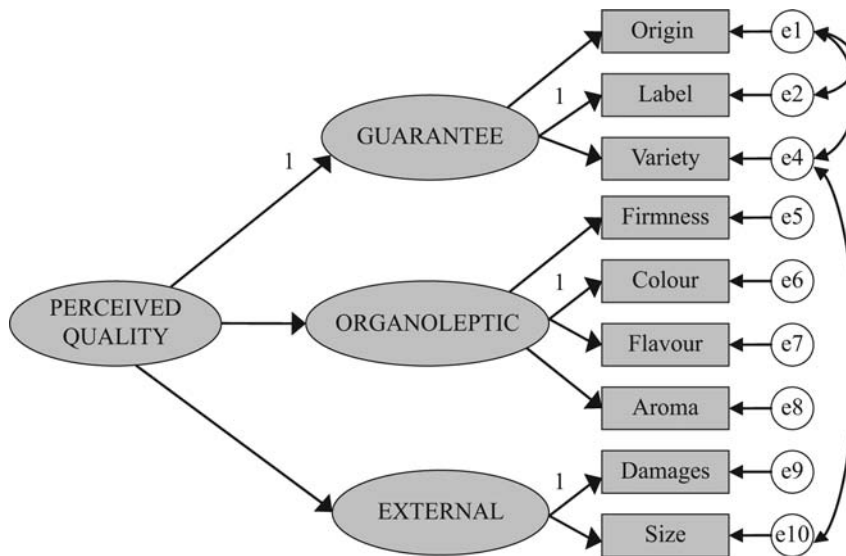


Figure 3.
Model 1b for perceived
quality of tomato

ORGANOLEPTIC	<-	PERCQUAL	1.000
GUARANTEE	<-	PERCQUAL	0.636
EXTERNAL	<-	PERCQUAL	0.624
Variety	<-	GUARANTEE	0.629
Origin	<-	GUARANTEE	0.416
Guarantee label	<-	GUARANTEE	0.373
Firmness	<-	ORGANOLEPTIC	0.571
Colour	<-	ORGANOLEPTIC	0.549
Flavour	<-	ORGANOLEPTIC	0.450
Aroma	<-	ORGANOLEPTIC	0.243
Damages	<-	EXTERNAL	0.491
Size	<-	EXTERNAL	0.451

Table VIII.
Standardized regression
weights. Model 1b

Therefore, the first model proposed for explaining the perceived quality of fresh tomato, obtained from EFA was a model formed by three latent variables and the following nine observable variables:

- (1) variety;
- (2) origin;
- (3) guarantee label;
- (4) firmness;
- (5) colour;
- (6) flavour;
- (7) aroma;
- (8) external damage; and
- (9) size.

Regarding latent variables, Guarantee and External Factors have a similar relative weight in explaining the perceived quality, which is lower than for Organoleptic Characteristics.

3.4 Model for perceived quality established from the theoretical framework: search, experience and credence attributes

Starting from the information economy approach, a model for perceived quality was proposed having three constructs: search attributes, experience attributes and credence attributes depending on whether quality could be inferred during purchase, during consumption or whether it was a question of credibility (Figure 4).

Observable variables proposed to constitute each construct are shown on Table X, coming from the classification discussed in section 1.2.

Table IX.
Summary of measures of fit for model 1b

	CMIN/DF	GFI	AGFI	NFI	CFI	RMSEA
Default model	1.449	0.983	0.965	0.921	0.973	0.034
Saturated model		1.000		1.000	1.000	
Independence model	11.200	0.774	0.718	0.000	0.000	0.143
Optimum values	1-3	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08

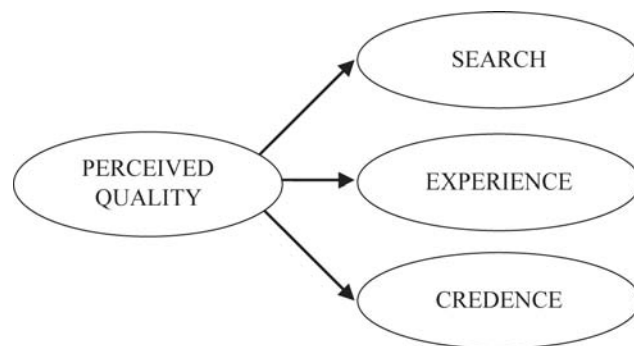


Figure 4.
Latent variables proposed for measuring perceived quality of tomato

All the variables except price are significant in the resultant model, having a level of significance of 0.01. Therefore, price was eliminated and relations were established among measurement errors as indicated by the modification indices provided by the programme. The resultant model is shown in Figure 5. Standardised regression weights and model fit indices are shown on Tables XI and XII respectively.

Although some model fit indices were found within recommended values, fit could improve with regard to NFI and the RMSEA. In searching for a better model to explain perceived quality of tomato, the brand variable was omitted for several reasons. In the first place, recognised brands are absent in the commercialisation of fresh tomato. Second, this attribute has little average importance in comparison with the others according to the results of the survey (See section 3.2). And third, it is the attribute having the least weight in the “search attributes” construct.

The resulting model and the standardised regression weights are shown in Figure 6 and on Table XIII respectively.

The result is a model with much better fit (Table XIV). Therefore, the second model proposed for the perceived quality of tomato is based on the differentiation among

Search	Experience	Credence
Price	Flavour	Variety
Damages	Aroma	Origin
Size	Firmness	Guarantee label
Colour		
Brand		

Table X.
Classification of tomato
attributes

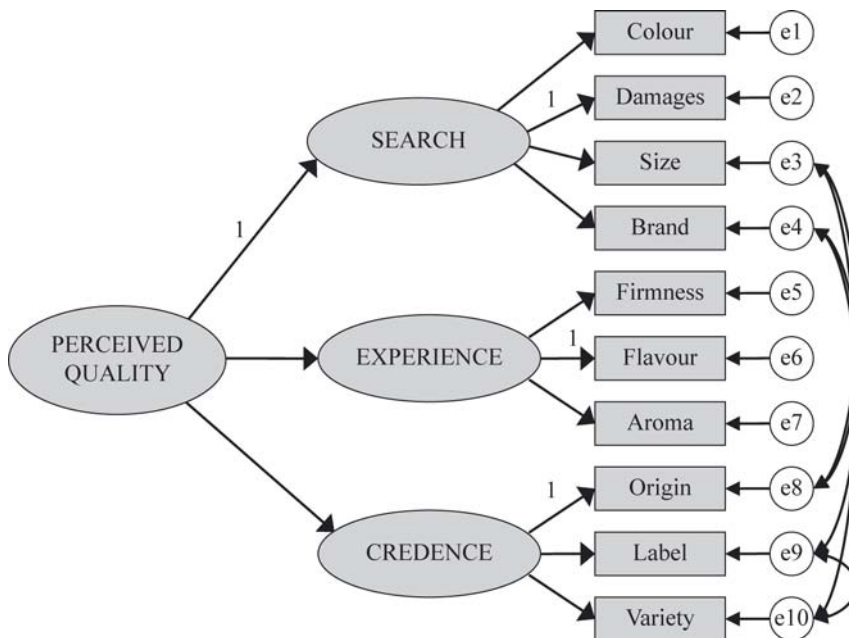


Figure 5.
Model 2a for the perceived
quality of tomato

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Table XI.
Standardized regression
weights model: 2a

SEARCH	<-	PERQUAL	1.000
EXPERIENCE	<-	PERQUAL	0.898
CREDENCE	<-	PERQUAL	0.487
Colour	<-	SEARCH	0.582
Size	<-	SEARCH	0.341
Damages	<-	SEARCH	0.326
Brand	<-	SEARCH	0.323
Variety	<-	CREDENCE	0.725
Guarantee label	<-	CREDENCE	0.687
Origin	<-	CREDENCE	0.597
Aroma	<-	EXPERIENCE	0.246
Flavour	<-	EXPERIENCE	0.453
Firmness	<-	EXPERIENCE	0.561

Table XII.
Summary of measures of
fit for model 2a

	CMIN/DF	GFI	AGFI	NFI	CFI	FMIN	RMSEA
Default model	2.351	0.970	0.941	0.861	0.912	0.165	0.058
Saturated model		1.000		1.000		0.000	
Independence model	10.526	0.756	0.702	0.000	0.000	1.187	0.155
Optimum values	1-3	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08	

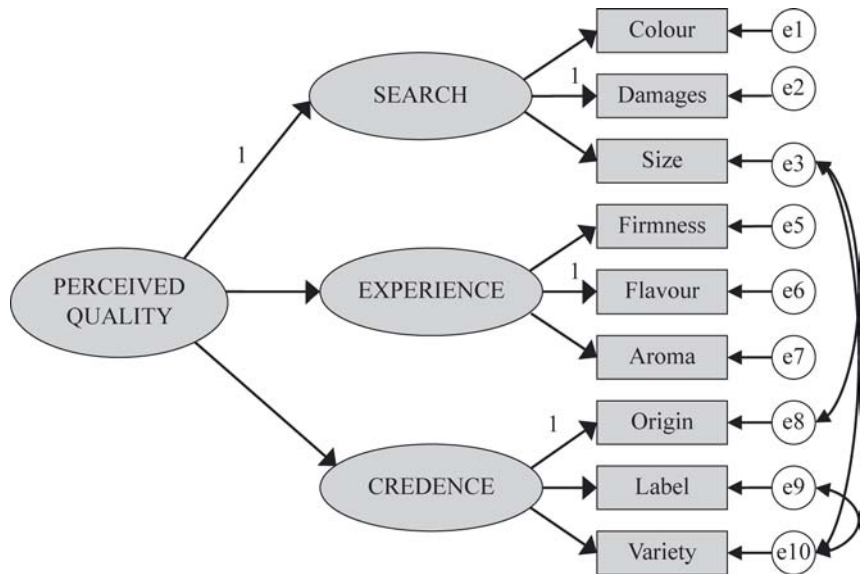


Figure 6.
Model 2b for the perceived
quality of tomato

search, experience and credence attributes. The perceived quality of tomato was explained by three constructs, with the search and the experience attributes being the ones that contributed the most toward explaining perceived quality. Colour was the attribute with the greatest importance in the explanation of the Search attributes,

SEARCH	< -	PERCQUAL	1.000
EXPERIENCE	< -	PERCQUAL	0.958
CREDENCE	< -	PERCQUAL	0.442
Colour	< -	SEARCH	0.555
Damages	< -	SEARCH	0.347
Size	< -	SEARCH	0.324
Firmness	< -	EXPERIENCE	0.572
Flavour	< -	EXPERIENCE	0.450
Aroma	< -	EXPERIENCE	0.238
Variety	< -	CREDENCE	0.734
Guarantee label	< -	CREDENCE	0.704
Origin	< -	CREDENCE	0.601

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Table XIII.
Standardized regression
weights: model 2b

	CMIN/DF	GFI	AGFI	NFI	CFI	FMIN	RMSEA
Default model	1.959	0.977	0.954	0.893	0.943	0.108	0.049
Saturated model		1.000		1.000	1.000	0.000	
Independence model	11.200	0.774	0.718	0.000	0.000	1.011	0.160
Optimum values	1-3	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08	

Table XIV.
Summary of measures of
fit for model 2b

although external damage and size also made up this construct. The attribute that contributed the most toward explaining the Experience attributes was firmness, followed by flavour, while aroma was found to have less relative weight. Lastly, among the Credence attributes, variety and the guarantee label stood out while origin had less weight. Price was not significant in the model for perceived quality.

3.5 Discussion of the results from both models

There are two basic differences between these two models. The first one is that in development starting from EFA, colour formed part of the construct that grouped together flavour, firmness and aroma, that is, the Organoleptic Characteristics. Meanwhile in the proposed model departing from the theoretical basis, colour constituted part of the Search attributes construct. After that, parallelism was observed between both models. Therefore, the Guarantee construct from the first model could resemble the Credence attributes construct of the second model; the Organoleptic Characteristics construct, the Experience attributes construct; and the External Factors construct, the Search attributes construct (Table XV).

The second difference lies in the fact that in Model 1b, the Organoleptic Characteristics had a much greater relative importance in explaining the perceived quality than the Guarantee or the External Factors. However, in Model 2b, Search and Experience attributes contributed the most toward explaining perceived quality.

Despite these differences in both models, the perceived quality of fresh tomato can be explained by the same nine attributes, since including price and brand was not significant. Likewise, in both models variety had a preponderant weight when explaining the perceived quality. Origin and the guarantee label had a weight similar to that of variety in Model 2b. However, in the model obtained from EFA, they lost importance as opposed to variety. The contribution of firmness, flavour and aroma had

Table XV.
Comparison of the
standardized weights of
models 1b and 2b

	Model 1b			Model 2b		
GUARANTEE	PERCQUAL	0.636	CREDENCE	PERCQUAL	0.442	
ORGANOLEPTIC	PERCQUAL	1.000	EXPERIENCE	PERCQUAL	0.958	
EXTERNAL	PERCQUAL	0.624	SEARCH	PERCQUAL	1.000	
Variety	GUARANTEE	0.629	Variety	CREDENCE	0.734	
Origin	GUARANTEE	0.416	Guarantee Label	CREDENCE	0.704	
Guarantee label	GUARANTEE	0.373	Origin	CREDENCE	0.601	
Firmness	ORGANOLEPTIC	0.571	Firmness	EXPERIENCE	0.572	
Colour	ORGANOLEPTIC	0.549	Flavour	EXPERIENCE	0.450	
Flavour	ORGANOLEPTIC	0.450	Aroma	EXPERIENCE	0.238	
Aroma	ORGANOLEPTIC	0.243	Colour	SEARCH	0.555	
Damages	EXTERNAL	0.491	Damages	SEARCH	0.347	
Size	EXTERNAL	0.451	Size	SEARCH	0.324	

a very similar influence on the corresponding latent variable, although in Model 2b they lost importance as opposed to colour among the Search attributes.

According to our results, firmness, flavour and colour, as organoleptic experience attributes, is the key to tomato commercialisation. In both models they are situated in the constructs most related to perceived tomato quality and besides they have a high specific weight within their construct. Colour is an attribute that can be examined at the place of purchase, but the same does not always happen with the other two attributes. Therefore, a recommendation with a view to commercialisation could be to select a sample of the product to be touched and tasted by the consumer at the place of purchase.

Aroma has a lower relative weight in its construct. It is not known whether this is due to the difficulty of carrying out this practice, the need for more tasting experience to determine fruit quality from the aroma or the complaint that consumers are making in recent years about the lack of aroma in fresh products.

On the other hand, concerning guarantee attributes (variety, origin and guarantee label), their importance when explaining perceived tomato quality is also relative in comparison to organoleptic attributes. Perhaps it is due to how few warranty brands there are for this product in the area under study.

3.6 Discussion of the results from price as an indicator of perceived quality in tomato
Regarding price, this research revealed that it had a declared importance somewhat superior to the average, since on a five-level Likert scale it obtained an average score of 3.88. It placed 5th in a set of 11 attributes. However, the results of this research question its utility as a cue to deduce the perceived quality of tomato.

Even though statistically the price variable has no place in the model, the explanation for this fact must be found. From the viewpoint of the authors, price is not a good indicator of quality in tomato for several reasons.

In the first place, price greatly reflects the seasonality of the product. The tomato purchaser cannot therefore depend on price as an indicator of quality, since it rather reflects the availability of the product on the market. Besides, the same tomato can decrease in price at any given establishment throughout the week. Logically this difference in price reflects the “deterioration” of the tomato as it moves away from the optimum time of consumption. This fact does not reveal a loss of intrinsic quality in the tomatoes, but rather the deterioration of its organoleptic qualities, since it is a perishable

product. This goes along the lines of what was stated by Zeithaml (1988), that among other factors, the use of price as a quality cue depends on the variation of prices within a class of products and the variation of quality throughout a category of products.

Second, the price of fresh fruit and vegetables varies greatly as the distance from the producer increases in the commercialisation chain. This characteristic, which is not exclusive to fruit and vegetables, does acquire preponderance in those products due to the ease with which the consumer buys directly from the producer at the market. Therefore, the consumer has a clearer idea of prices at their source.

This research would not agree with price being used quite frequently as a quality indicator in products without a brand name (Bredahl, 2003), since, as commented above, tomato is a product whose commercialisation brand is hardly known to the consumer. However, it is a product of frequent purchase and therefore very familiar to the consumer, so the use of price as a quality cue decreases, which does coincide with what the above author explained.

4. Conclusions

The purpose of this paper is to further progress in research on models for perceived quality of fresh fruit and vegetables through the development of two models for the perceived quality of tomato. One of them was formulated from an exploratory factor analysis and the other one started from the theoretical basis. Both were adjusted by means of structural equation analysis.

In spite of a few differences in the contribution of some attributes toward explaining the perceived quality, both models showed great similarity.

Both established that the perceived quality of fresh tomato could be explained through nine attributes. Some of them can be deduced at the place of purchase; some, during consumption while others are a question of trust.

One model cannot be concluded as being better than the other, as far as statistical fit is concerned. If one model had to be chosen, it would be Model 2b, because it was developed from theory and because the minimum number of recommended indicators for measuring a construct is three (Hair *et al.*, 1999). Therefore, Model 1b would be rejected, whose External Factors construct was formed by only two indicators.

From our viewpoint, the most important attributes when explaining perceived quality in tomato are firmness, colour, and flavour. Therefore these experiences should be provided to consumers at the place of purchase. Regarding guarantee or credence attributes, much more work is necessary to introduce guarantee brands warranties or a label fulfilling consumer quality expectations.

With regard to using price as an indicator of the perceived quality of tomato, both models suggested the elimination of this variable from the model for perceived quality. It is an influential attribute in the tomato consumer decision to purchase, as revealed by the declared average importance, but not as an indicator of perceived quality. This fact could be explained because tomato is a product that has a large price variability as well as consumer familiarity with the product.

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