LINK BETWEEN PRODUCT QUALITY AND PRICE EXAMINED ON POTATO CHIPS

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Abstract

Ensuring the quality of food is a multifaceted topic, full of information about raw materials, interactions between cultural attitudes, genetic and environmental factors. A questionnaire survey was conducted in the Czech Republic to measure five variables, i.e. sensory analysis (SA), nutrition facts (NF), ingredients (IN), quality label (QL) and price (P), for further investigation. Using the commodity of potato chips, we analyse the differences between individual items and the mutual connection to consumer price evaluation after package presentation. Among others, MANOVA for repeated measures, discriminant analysis (DA) and canonical correlation analysis (CCA) are the processing methods of choice. While some chips scored well in sensory, others excel for their various ingredients and labels of quality. The decisive parameters for final pricing act contrary, with nutrition seems the least significant factor in general. Ingredients and QL are positively related and cover all the cases considered here, reflecting the eligible role of quality evaluation based on our sample data.

Key words: discriminant analysis, canonical correlation analysis, potato chips, quality, price evaluation

JEL Codes: C13, L1

Introduction

Topics such as product quality, consumer protection and safety are currently discussed, covering both domestic and European levels (Bertin & Génard, 2018; Giusti, Bignetti, & Cannella, 2008). Consumers are becoming more critical in their choices of food, including origin, methods of production, composition, and various quality labels. Valenta et al. (2011) mention a growing segment of consumers interested in food safety and quality that positively relate to the environment, and to the more efficient use of natural resources and domestic raw materials. In this context, Codex Alimentarius, a collection of internationally accepted standards, guidelines, and other recommendations, becomes an important source of information for consumers, food producers and processors, national food control agencies and

international trade for dealing with food quality. Quality is perceived both objectively and subjectively (Giusti et al., 2008). While objective evaluations refer to physical properties, nutritional value, product safety, shelf life, and other factors, subjective quality is associated with the way in which products are perceived by the human senses. According to an EU survey, about 96% of citizens find that, when buying food, quality is ranked as a more important factor than origin or brand (European Commission, 2020).

When buying food, people in the Czech Republic most often consider its freshness and quality (about 90%). Less important is the habit of buying specific products, the wishes of family members, or even the price (for 2/3 of people). Despite fact that price is significantly related to the product parameters of this study, quality and freshness are generally decisive, as only 17% of respondents give price top priority (STEM/MARK, 2020). Czechs also prefer regional products over others because they believe in the quality of Czech food. Chalupová et al. (2020) suggested discussion on reducing the number of food labels, amendments to packaging laws and support for newly established labels, but qualitative indicators remain significant. As a way of informing consumers on the quality attributes of a selected product, brands used only for food products (e.g. Klasa label or Regional Grocery) or brands that are also included in other product categories (e.g. Czech Product) can be searched. According to STEM/MARK (2020), Klasa is spontaneously recognized (55%) and supported (88%) as the best-known food quality label in the Czech Republic. This mark is associated with proven Czech products and products of high-quality composition. Other well-known marks include Regional Grocery, Czech Product, and Czech Grocery, as half of the respondents declare their awareness of them.

There are plenty of models used for potato chips and other commodities. For example, Mendoza, Dejmek, & Aguilera (2007) apply classification analysis and logistic regression to reveal consumer preferences based on various features of texture and colour. On the other hand, Viswanathan, Hastak, & Gau (2009) have studied the low-literate consumers and their connection to use the information on nutritional labels, together with the ways such usage can be facilitated. By tools of multivariate analysis, they moreover examine the influence of various graphical and non-graphical formats on the usage of nutrition information. In this study, MANOVA for repeated measures, DA and CCA are applied (Vehkalahti & Everitt, 2019). Although in the Spanish work by Rebollar et al. (2017), the image of the packaging marginally placed above the text, we revealed significant relations within the scope of other more relevant properties.

1   Questionnaire survey data

A food quality assessment questionnaire was created to find out consumer preferences, including the significant factors of choice and additional ratings. The 201 observations examined in this study have been measured for the five variables of SA, NF, IN, QL, and P. The P parameter, after package presentation, serves to determine the overall evaluation of the product brand. The recently performed survey uses social media sources, students at the University of Chemistry and Technology in Prague, professionals from selected companies, and the public. All the questionnaires that are part of this work were conducted in electronic or written form. The 5-point Likert scale was systematized to reflect the opinion of the respondents on a selected product: 1 – as the least favourable answer, 5 – the most favourable. We studied Bohemia, Strážnické and Lays chips. Although produced by the same company, Intersnack Czech Republic, they were selected for their diversification properties and specific characteristics in the full range of their portfolios. Note the certifications, Klasa for Bohemia and Czech Product – guaranteed by the Federation of the Food and Drink Industries of the Czech Republic for Strážnické.

Food quality generally includes characteristics such as appearance, structure, taste, legislatively defined characteristics (like nutritional parameters, commodity, and safety), specific normative requirements, hygienic requirements for food processing, and social and religious requirements. Below are the fundamental characteristics of the selected products introduced:

Bohemia chips salted – Fried potato chips salted
Ingredients: Potatoes, sunflower oil (35%), table salt (max. 2.2%)
Nutritional facts: 2253 kJ (541 kcal) / 100 g
Weight: 150 g

Strážnické potato chips lightly salted – Potato chips fried salted
Ingredients: Potatoes (62%), rapeseed oil (36%), salt (2%)
Nutritional facts: 2270 kJ (544 kcal) / 100 g
Weight: 40 g

Lays salted – Fried potato chips salted
Ingredients: Potatoes, vegetable oils (the palm and sunflower oils in various proportions), edible salt (1.4%)
Nutritional facts: 2192 kJ (526 kcal) / 100 g
Weight: 150 g

A preliminary processing of the data provides the following weights sorted by significance: ingredients (33.4 %), sensory analysis (22.1 %), nutrition facts (11.7 %), country of origin (8.8 %), producer (7.3 %), packaging design (5.9 %), quality label (5.4 %) and trademark (5.4 %). These are important for interpreting the results of the analyses, and we further selected those, that represent the individual branches of the topic. First, the participants of the survey observe an introductory questionnaire, then pass a sensory evaluation, and the assessment of the information declared on food packaging. They were asked to include sensory aspects such as consistency, texture, colour, smell, and salinity. Only for the last question about the price of such product (in CZK) were the respondents informed which products were tested. About 60% of the sample group consisted of women, most often people with secondary and university educations, aged between 20 and 40.

2   Methods

Although the data used in this study are based on the Likert scale or ordinal variables, such measures can be approximated as continuous (see, e.g., Johnson & Creech, 1983). In this sense, the scale variable as an ordinal approximation of the continuous one is perceived. We use multivariate approaches of MANOVA for repeated measures, DA and CCA to generate latent variates (LVs) as linear combinations of original variables for solving the optimization task assigned. While the differences between sets are evaluated in DA, in CCA the correlations between two sets of variables are of interest (Vehkalahti & Everitt, 2019; O'Brien & Kaiser, 1985). We were specifically directed to interpret the coefficients of linear combinations and derived measures. In addition to multivariate techniques, some of the univariate approaches concentrated on the initial evaluation have also been used. We have applied the multivariate test developed by Henze & Zirkler (1990) and the Shapiro-Wilk test to evaluate data normality.

The MANOVA for repeated measures approach is a valuable alternative to mixed-effect model analyses (O'Brien & Kaiser, 1985). The violations of the sphericity significantly influence Type I error rates and the power of the mixed-model tests. Due to a variety of specific approaches covering the experimental hypotheses, MANOVA for repeated measures is more useful for many cases. Despite usual statistics such as Wilks' lambda, Lawley's trace and Roy's largest root being on average more powerful than Pillai's trace, the last one mentioned is robust to departures from input assumptions. While statistics for MANOVA with repeated measures demonstrate exquisite statistical properties, we also descriptively

examine the differences between means in individual sets by DA methodology. The standardized input variables, i.e. correlation matrix in canonical correlation technique, is used herein. We apply the canonical coefficients with one variable in the set corresponding to multiple regression using the intercept, and vector of coefficients for unit norm (Vehkalahti & Everitt, 2019). Structural correlations are not considered due to decrease the dimension of solution space. The R software (R Core Team, 2019), together with several built-in functions and libraries like MVN (Korkmaz, Goksuluk, & Zararsiz, 2019) and MASS (Ripley et al., 2021), are used in this study.

3   Initial data evaluation

Covering Shapiro-Wilk and multivariate Henze-Zirkler normality tests, the statistical sets seem to deviate significantly (p-values often < 0.01) from the normal distribution. Since transformations such as Box-Cox do not correct the cases, we exclude some outlying observations. The quantile method based on Mahalanobis distance is applied. Table 1 introduces some descriptive statistics after excluding outliers in individual sets. It consists of 195 observations for Bohemia, 196 for Strážnické, and 193 for Lays. Generally, Lays have the best rated SA while very distant and lowly evaluated for IN in comparison to others, as well as for QL. Because of package weight, the highest valued are Strážnické.

Tab. 1: Descriptive statistics

	Mean[*]	StDev	Skew	Med	Ran
Bohemia					
SA	2.979	0.974	0.041	3	4
NF	3.559	0.753	0.124	4	3
IN	3.508	0.846	0.103	3	3
QL	3.908	0.740	–0.005	4	3
P	26.02	7.592	0.011	25	32
Strážnické					
SA	3.092	1.029	–0.155	3	4
NF	3.107	0.726	0.477	3	3
IN	3.857	0.894	–0.232	4	3
QL	3.709	0.753	–0.118	4	4
P	19.51	7.182	0.516	20	35
Lays					
SA	3.819	0.920	–0.474	4	4
NF	3.503	0.879	–0.008	3	4
IN	2.876	0.787	0.221	3	4
QL	2.927	0.564	0.849	3	3
P	25.58	8.366	–0.096	25	37

[*]The meaning of abbreviated characteristics follows: Mean – sample arithmetic mean, StDev – sample standard deviation, Skew – sample skewness, Med – median and Ran – range of data

Source: authors

By exclusion of 17 most important outlying observations unifying all sets for the repeated measures approach, the illustrative pattern is evident from the graphical representation (see Figure 1). Excepting Lays, the explanatory power of arithmetic means is relatively similar.

Fig. 1: Graphical representation of 95% confidence intervals for individual means
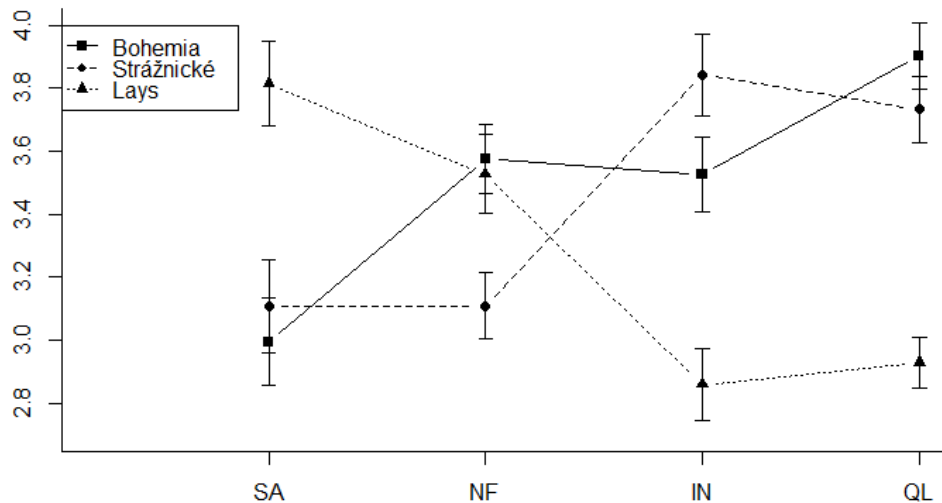
Source: authors

Bohemia and Stážnické are revealed to have significant two-dimensional correlations for P with other parameters, based on the t-test. Especially for Bohemia, we find the important positive relations for both IN and QL, while in the case of Strážnické, SA is positively related to P. Note the 0.05 significance level applied to relations between sets. Within the sets, IN with QL, then SA with NF, and NF with QL, are positively correlated for Bohemia chips. For Strážnické, IN with QL and NF with IN are the most positively related, while SA with NF is connected negatively. In the case of Lays, IN with QL is also positively related.

4   Multivariate analysis

According to the results of MANOVA for repeated measures, at least one set is significantly distant for Wilks' lambda and Pillai's trace tests with p-values < 0.01. The proportion of trace in discriminant analysis gives a much higher priority to a first latent variable for 85.75 % of explained variance. It seems in Table 2, SA and NF are separated differently from others due to the sign at the first latent variable, what confirms the preceding information. Omitting QL, Lays are especially low rated, while being very well evaluated in terms of SA. On the other hand, IN and QL for Bohemia and Strážnické are better rated. The less significant direction reveals that the NF and QL parameters are especially separated conversely to IN.

Tab. 2: Coefficients of linear discriminants

	SA	NF	IN	QL
LV#1	–0.509	–0.270	0.479	1.051
LV#2	0.269	–0.969	0.743	–0.678

Source: authors

The coefficients for individual chips covering CCA output are in Table 3. Such a situation with only one variable P in the second set provides total F-tests significant at 0.01, excluding Lays. The results are in accordance with a two-dimensional setting, as IN and QL are the most important for Bohemia, while SA is decisive for Strážnické chips with a smaller influence of QL. In the case of Lays, the best evaluated for SA, its price dependence is relatively important contrary to QL. The high negative value of the coefficient visible for the QL covering Lays reflects the fact that these chips are not rated by any quality label in the Czech Republic.

Tab. 3: Canonical coefficients

	SA	NF	IN	QL
Bohemia	–0.199	0.302	0.711	0.807
Strážnické	0.876	–0.058	–0.262	0.544
Lays	0.849	–0.091	–0.219	–0.794

Source: authors

Conclusion

As food quality includes many direct and induced parameters that affect the properties of the final product, the results of this study can be used to improve quality awareness with the marketing applied. The outputs of MANOVA for repeated measures and DA demonstrated the outstanding separation for QL and IN differently from SA. Despite the fact, that Lays are the best evaluated from the side of SA, no highly significant correlation to price is revealed in comparison to the parameters of other chips. On the contrary, both Bohemia and Strážnické are the best rated for IN and QL. But regarding Bohemia, the connection of those parameters to price is especially significant. While SA for Stážnické is the lowest evaluated in comparison to other parameters for the same chips, it is decisive for final pricing. Note that at Bohemia, the quality label is generally the most important according to the initial rating of respondents, and this is also the fundamental parameter that covers price evaluation. It seems nutritional facts are not generally so important parameter for final product pricing. Also note IN and QL within the sets are positively related in all cases, something that reflects the essence of quality label evaluation.

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