Anna Szabó[1]

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Using conjoint analysis for the consumer optimization of champignon products with enhanced vitamin D content

Keywords: conjoint, marketint research, consumer preference, vitamin D, champignon.

SUMMARY

One of the latest results of developments related to cultivated mushrooms in recent decades is champignons with an enhanced vitamin D content, which help fight global vitamin D deficiency as a natural source of vitamin D. In the assessment of this new product from a consumer point of view, conjoint analysis was used for the first time, and it proved to be effective in identifying consumer needs, and may help product development with valuable information. The conjoint analysis, previously not used in the case of mushroom products, showed that it is the Hungarian origin and the enhanced vitamin D content which is most appreciated by consumers when judging the product. Through carrying out the survey with the joint recording of socio-demographic data, consumer groups can be identified, creating a potential for targeted marketing.

Introduction

Nutrition physiology role of champignons

Worldwide, the number of functional foods is growing. The reason for this is that vitamin intake from natural sources as part of a healthy diet is preferred by conscious consumers. There is also a steady increase in the supply of foods with high vitamin and antioxidant contents. Evaluation of a new product should only be carried out via an integrated approach, taking into account nutrition physiology aspects, nutrition properties, consumer assessments and sensory factors together. A complex analysis can provide easy-to-use information for the practice, thereby contributing to the development of a product that is valuable in terms of nutrition indicators on the one hand, and attractive and acceptable to the consumer side thanks to product optimization originating from consumer needs on the other hand.

Based on international research carried out over the past decade, it has been found that vitamin D deficiency is endemic disease these days **[1]**. One of the reasons for this high incidence of vitamin D deficiency is that there are relatively few natural sources of it with limited availability **[2]**. Since a large portion of the Earth's population is affected by vitamin D deficiency, at the end of the last century, several nutrition science research projects have focused on the artificial production possibilities of vitamin D and on making it widely available in the form of a dietary supplements containing vitamin D or foods enhanced with vitamin D. Thanks to these initiatives, a number of products have become widely available by today (pills, drops). However, conscious consumers prefer vitamin intake from natural sources, therefore, in recent decades, the objective of several research project was to develop products that have a high, but natural vitamin D content **[3, 4]**.

Because of their low energy content and high nutrition value, mushrooms are important elements of a healthy, modern diet. In addition to their beneficial nutrition physiology effects, they also contain natural vitamin D **[5]**. A simple procedure, using UV lamps, can increase the otherwise low vitamin D levels of cultivated mushrooms, thereby creating a product that can be incorporated into the diet as a source of natural vitamin D.

[1] Szent István University, Faculty of Horticultural Science, Department of Vegetable and Mushroom Growing

Conjoint analysis

Conjoint analysis is a tool for testing consumer behavior associated with certain services and products. As a marketing research method, consumer habits are represented by a unified scale. One of the most important elements in the evaluation of cultivated mushrooms with an enhanced vitamin D content as a product to ensure the stability of production, furthermore obtaining a rational diagnostic system for their diseases in time **[6, 7]**. In addition, the exploration of consumer needs and opinions is indispensable for market sales. In connection with this, it should be emphasized that foodstuffs have become not only commercial items nowadays, but more and more items of food safety, as well as emotional issues and items of trust for consumers **[8]**. At the same time, product types have been divided into subgroups by the literature from several points of view, in terms of usefulness, retail, product life cycle, consumer quality assessment, the degree of consumer activation, involvement and consumer engagement **[9, 10]**. The theory of diffusion examines how consumers relate to new things and at what rate, in which waves they accept phenomena and products that are foreign to them. Based on these, consumers can be typed: innovators, early adopters, early majority, late majority, laggards. It is important to emphasize that people are often considered to be innovators in some respects, while in other respects they are not. Elderly people typically belong to the late majority or to laggards **[11, 12, 13]**.

Understanding consumer behavior and decision-making has been a central topic of food companies and the practice of market research for decades. In this context, numerous theoretical models have been developed from general to product-specific models. It is a general paradigm that products developed on the basis of consumer needs with market demand provide the basis for consumers to be satisfied and repeat their purchases **[14, 15, 16]**. In this case, products adapt to consumers. However, in the case of products with geographical indications or protected designation of origin, the image is more subtle, the main focus being on the product, in which case consumers tend to adapt to the products **[17, 18]**.

Accelerated lifestyles, supply-driven food trade, the new shopping environment and growing in-store marketing tools have induced new consumer habits. This is why the application of product testing methods focusing on purchasing decision situations has come to the fore. Many papers have been published regarding product that provide nutrition benefits in a wide range of product categories, such as mineral waters **[19]**, flavored mineral waters **[20]**, tea drinks **[21]**, apple drinks **[22, 23]**, pasta and bread made from special flours **[24, 25]**, different coffee blends **[26]**, flavored kefirs **[27]**, tomatoes **[28, 29]**, basil **[30, 31, 32]**, thyme **[33, 34]** apples **[35, 36]**. Nowadays, more and more sophisticated tools for predicting utility-based consumer behavior have emerged, such as field observations, media watch, eye tracking, brain wave detection, etc. **[37, 38, 39, 40, 41]**.

In addition to the development of tools, several new methodologies have been developed as well. One such method is preference mapping developed for the sensory optimization of products, the essence of which is that a mathematical relationship is defined between the consumer and expert judgements of a given product group **[42]**. Key factors include consumer representativeness, the statistical methods applied **[43, 44, 45, 46, 47, 48]** and the evaluation and follow-up of the performance of expert judges **[49, 50, 51, 52, 53]**. To reveal consumer preferences, special statistical methods are used in consumer surveys, such as the generalized pair correlation method **[54]** or the sum of ranking differences method **[55]**.

The technique of conjoint analysis determines the relative weight of the aspects influencing *consumer decision-making*, as well as consumer benefits associated with product levels. The essence of a product-centered approach is that the product is viewed as a set of properties, the sum of which gives the full usefulness of the product. The utility function is the usefulness relationships of product properties as perceived by the consumer. The objective of conjoint analysis is to determine the points of this function. In the course of the statistical analysis, linearity is assumed by the method, where utility values are signed additive quantities. Conjoint analysis considers preferences dependent and factors independent variables, and takes into account only the main effects, considering the interaction of the individual factors negligible **[56, 57]**.

The method of conjoint analysis is essentially a simulated shopping situation where product combinations are compared by the respondents, with the knowledge of given product characteristics and their levels. The impact of the different characteristics on consumer decision varies, and the results are based on the *subjective opinion* of the respondents. The advantage of the method is that the conjoint method makes it less possible for the respondent consciously influence their true opinion. The steps of conjoint analysis are as follows **[58, 59, 60]**:

1. Selection of the product properties to be examined
2. Defining the product groups
3. Determining the levels of the different product properties
4. Developing the combinations of the determined product property levels (stimuli)
5. Determining the method of conjoint analysis
6. developing the conjoint analysis questionnaire
7. Filling out the conjoint analysis questionnaire
8. Selection of the analysis method, analysis, interpretation of the results

In the course of conjoint analysis, two main data collection methods are distinguished. In the pair-wise process, participants always compare only two factors at a time, until all the pairs have been completed. The task is not too difficult, but due to its lengthy nature, it can lead to mental fatigue. In the full profile evaluation, the complete profiles of the product combinations are compiled with the inclusion of all features, and they are presented on a separate card. Conjoint analysis is most often used to evaluate product combinations (rating) or ranking, or is choice based **[61]**.

Conjoint analysis has been used for a wide range of foods, however, no published results can be found in the literature and in international databases regarding the product optimization of UV-treated mushroom products with enhanced vitamin D content. The enduring popularity of conjoint analysis is due to its practical results, as evidenced by the latest Hungarian and international publications: pizza **[62]**, apples **[63]**, margarine **[64]**, wine **[65]**, beer **[66]**, functional foods **[67]**, olive oil **[68]**, lamb **[69]**, soybean oil **[70]**, GM yogurt **[71]**, mineral water **[72, 73]**, marine fish **[74]**, probiotics **[75]**, beef **[76]**, locally grown strawberries **[77]**, latte-style coffee drinks **[78]**.

Objectives

The success of a new market product is influenced by a number of factors, e.g., price, origin, package size, type of packaging, added value (enhanced vitamin D content) etc. We assume that if a product combination meets consumer expectations, then that product is chosen more often by consumers and they will repeat their purchases. Therefore, product optimization based on consumer needs is of paramount importance, and during this we look for the answers to the following questions:

1. Which product-related factors influence mushroom consumers?
2. What is the relative weight of each product characteristic in consumer decision-making?
3. Which is the ideal product combination among the consumers examined?
4. What are the usefulness levels of the individual product characteristics for the consumers?

Materials and method

At the Department of Vegetable and Mushroom Growing of the Faculty of Horticultural Science of Corvinus University (today: Szent István University) the pre-harvest UV treatment of cultivated mushrooms in order to increase their vitamin D content has been a years-long research project. In cooperation with the Department of Applied Chemistry of the Faculty of Food Science, we managed to optimize this and determine the most effective UV treatment method for each cultivated variety or species (champignons, chestnut mushrooms and oyster mushrooms) tested. Based on the results, champignons treated with UVB radiation for a total of 60 minutes in the 3 days before harvesting were examined as a potential functional food in the Sensory Analysis Laboratory of the Faculty of Food Science **[79]**.

The general aim of focus group research is to get to know the participants' opinions, thinking, priorities and typical sources of information during conversations conducted typically with 10-12 people in a permissive atmosphere **[80, 81]**. The explicit purpose of the consumer focus group study was to determine the input data for the conjoint method. To this end, our objective was to identify decision elements, product characteristics and product characteristic levels considered to be important by consumers from champignon purchasing point of view.

Special moderator skills are key to the success of the focus group, therefore, focus group interviews were conducted with the help of a moderator, whose task was to monitor the reactions of the participants and to direct the conversation, among other things, and to ensure that the group is not dominated by a single participant. Members of the focus group were exclusively housewives, aged 25 to 70. A total of four focus group studies were conducted, warranted by the nature of the topic and the homogeneity of the opinions, the fourth interview provided only minimal new information. The conversations took place in a relaxed environment, in a separate room, with chairs in a circle, in a permissive atmosphere. The focus group discussion always started with a brief introduction of the moderator. It was emphasized by the moderator on each occasion that the objective was to get to know the opinion of each participant, and the group was ensured that there were no right and wrong answers. Notes on the discussions were taken each time. Focus group discussions typically took 2 hours. After the conversation, participants were given 500 g of champignons as a gift. During our research, semi-structured interviews were conducted where the thread of the questions had been prepared in advance **[81]**.

From among the methods, conjoint value analysis was selected, conjoint cards (product combinations) were created, which were reduced with the help of the SPSS 22.0 software package using the orthogonal array method. For the generation of the cards, the following command line was used:

```
ORTHOPLAN
  /FACTORS=
ar ,ár' (1 ,300' 2 ,450' 3 ,900')
marka ,márka' (1 ,sajátmárkás' 2 ,gyártói márkás')
faj_fajta ,faj_fajta' (1 ,fehér csiperkegomba' 2 ,barna
csiperkegomba' 3 ,laskagomba')
kiszereles ,kiszerelés' (1 ,250g' 2 ,500g' 3 ,1000g')
csomagolas ,csomagolás' (1 ,műanyag tálca'  2
,háncskosár' 3 ,ömlesztett')
```

```
taplalkozasi_elony ‚táplálkozási előny' (1 ‚megnövelt
D-vitamin tartalom' 2 ‚D-vitamin forrás' 3 ‚megnövelt
antioxidáns tartalom' 4 ‚antioxidáns forrás' 5 ‚B-vitamin
forrás' 6 ‚kálium forrás')
szarmazas ‚származás' (1 ‚magyar' 2 ‚lengyel' 3 ‚román')
kalap_merete ‚kalap mérete' (1 ‚3-4cm' 2 ‚5-6cm' 3 ‚7-
8cm' 4 ‚10-15cm')
termesztes ‚termesztés' (1 ‚bio' 2 ‚nem bio')
 /REPLACE.
_DATASET NAME GombaConJointTerv.
```

The 32 cards created were encoded with three-digit unique random numbers between 100 and 999 using the Microsoft Office Excel software package. To eliminate the ordering effect in the evaluation, the samples were presented in a new random order after each 40 answers.

The cards were evaluated by the consumers in a Google document. At the end of the questionnaire, questions related to mushroom consumption and socio-demographic questions were asked to characterize the consumer segments (frequency of mushroom consumption, type of mushroom purchased, net income of household, highest completed level of education of the head of household, occupation of the head of household, residence). The questionnaires were completed by 306 people. Data exported from the Google document were evaluated using the conjoint module of SPSS. The opening page, the instructions for consumers and two conjoint cards can be seen in **Figures 1 and 2**.

Results

Focus groups determined the most imoprtant decision factors (9 product attributes) based on their mushroom purchases, and the corresponding separate levels were defined:

- price: 300 HUF, 450 HUF, 900 HUF
- brand: own brand, manufacturer's brand
- species/variety: champignons, chestnut mushrooms, oyster mushrooms
- packaging: plastic tray, bark basket, bulk
- package size: 250 g, 500 g, 1000 g
- other nutritional benefits: enhanced vitamin D content, vitamin D source, increased antioxidant content, antioxidant source, viamin B source, potassium source
- origin: Hungary, Poland, Romania
- cap size: 3-4 cm, 5-6 cm, 7-8 cm, 10-15 cm
- cultivation: organic, not organic

The general results of the full-profile approach used in the research are as follows: relative importance values of the decision factors, usefulness values of the product characteristic levels, ideal product. Thus, the results are presented accordingly.

In the first step, respondents who do not consume mushrooms at all were eliminated, leaving 273 people out of 306. Joint evaluation was carried out based on the opinion of mushroom consumers. Based on the relative importance values of the decision-making factors of all respondents, the most important are origin (18.2%), nutritional benefit (15.6%), price (14.3%) and package size (13.1%). These are followed by cap size (9.9%), species/variety (8.6%), cultivation (8.4%) and packaging (8.0%). Brand perception plays a minimal role in the decision (3.2%). Based on the joint assessment, the product optimized for consumer needs is manufacturer's brand champignons of Hungarian origin, with an enhanced vitamin D content, priced 300 HUF, in a 1,000 g package, with cap size of 7-8 cm, from organic cultivation, in a bark basket.

It was assumed that the total set of 273 respondents did not form a homogeneous consumer group. To check this assumption, cluster analysis was required. Based on consumer responses of the conjoint analysis, three consumer segments with similar decision patterns were identified. The result of this is that consumers within a particular group are most similar to each other in their decision-making mechanisms, while they differ from consumers outside the group. For us, the important correlation of the dendrogram is the structure. Analyses were carried out using the XL-Stat software.

Characterization of the consumer clusters was carried out by analyzing the responses to the questions of the conjoint questionnaire related to socio-demographic data. Consumer cluster 1 contains 64 people, 27 men (42%) and 37 women (58%). Typically, they are between 30 and 50 years of age, consume mushrooms each month, their average net income is 151 to 300 thousand HUF, the head of the family typically has a college education, the occupation of the head of the family typically falls into the category of white-collar work, and they live in a big city. Cluster 2 contains 122 people, 47 men (38%) and 75 women (62%). They are over 50 years old, consume mushrooms every two weeks, their average net income is 151 to 300 thousand HUF, the head of the family typically has a high school education, entrepreneur or member of the professions, they live in small or medium-sized towns. Cluster 3 contains 87 people, 34 men (64%) and 53 women (36%). Typically, they are between 20 and 40 years of age, consume mushrooms every two to four weeks, their average net income is 151 to 300 thousand HUF, the head of the family typically has a high school or college education, a white-collar worker, they live in cities.

Based on the relative importance values of the decision factors of consumer cluster 1, the most important is the origin of the product (40.4%). This is followed by nutritional benefits (11.9%), packaging (11.3%), price (9.5%), brand (8.5%) and packaging size (8.1%). Cap size (3.8%), species/variety (3.4%) and cultivation (2.7%) play insignificant roles in the consumer decision. The product optimized for the consumer needs of this segment is manufacturer's brand champignons of Hungarian origin, with an enhanced vitamin D content, in a bark basket, priced 300 HUF, in a 1,000 g package, with a cap size of 5-6 cm, from organic cultivation.

Based on the relative importance values of the decision factors of consumer cluster 2, the most important are the origin (19.6%), the nutritional benefits (16.8%) and the price (12.7%). These are followed by cap size (11.3%), packaging size (9.9%), cultivation (9.8%), packaging (8.2%) and species/variety (8.1%). Brand plays an insignificant role (3.2%). The product optimized for the consumer needs of this segment is own brand oyster mushrooms of Hungarian origin, with enhanced vitamin D content, priced 300 HUF, with a cap size of 7-8 cm, in a 1,000 g package, from organic cultivation, in a bark basket.

Based on the relative importance values of the decision factors of consumer cluster 3, the most important are the packaging size (20.5%), the price (20.4%), the nutritional benefits (13.7%), origin (9.8%), species/variety (9.5%), cap size (9.2%) and packaging (8.1%). The least important decision factors are cultivation (5.2%) and brand (3.3%). The product optimized for the consumer needs of this segment is manufacturer's brand chestnut mushrooms of Hungarian origin, in a 1,000 g package, priced 300 HUF, with an enhanced vitamin D content and a cap size of 7-8 cm, in a bark basket, from organic cultivation.

Conclusions

Based on the results of the conjoint analysis of champignons treated with UVB radiation for 60 minutes, it can be concluded that the increased vitamin D content has greater utility for consumers and, therefore, should be placed at the center of communication. On the basis of the results of the conjoint analysis, the relative importance of the decision factors of the consumers examined, their utility values and the ideal product combination were determined. Combining this with cluster analysis, the different consumer segments and the product combinations optimized for consumer needs were identified and characterized. As a result of these developments, the range of healthy functional foods can expand by a product optimized for consumer needs which, without the addition of artificial substances, thanks to its natural ingredients, along with its many other beneficial nutrition physiological effects, helps to ensure the vitamin D supply of the body.

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