



## Consumer acceptance of combined hot-air and microwave vacuum-dried apple pieces

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**Abstract.** The microwave vacuum-dried apple has a puffy and crispy structure; so, it can be a new promising product for the replacement of traditional snack products, which contains a high level of fat and salt. In order to analyse the consumer acceptance regarding the microwave (MW) vacuum-dried apple pieces, a rating-based conjoint analysis with sensory tasting (MW vacuum-dried piece and hot-air dried slice) was done. This study was performed with the help of three attributes: appearance (piece/slice), applied technology (MW vacuum-/HA drying) and price (average/+20%). Data were analysed with SPSS Conjoint. On the basis of the results of 420 respondents, it was found that without tasting respondents could not decide which product they would have liked to buy: MW vacuum-dried apple piece on average +20% price or HA-dried apple slices on average price. However, having tasted, the “piece” appearance resulted a significantly positive utility, while the “slice” a negative one. Significant difference was not observed between the utility values of the applied technologies. Average and higher price resulted negative utility. Although the utility values of the technology did not show a significant

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difference, these had the highest impact on the shopping decision, closely followed by the appearance. It can be concluded that a general rejection against the MW vacuum drying technology was not observed. The sensorial characteristics of the microwave dried apple pieces had a favourable impact on the shopping decision.

## 1 Introduction

Apple is harvested in the largest amount (650,595 tons/year) (*KSH*, 2013a) and it is the most frequently consumed (9.6 kg/capita/year) fruit in Hungary (*KSH*, 2013b). The popularity of this fruit can be partly due to the fact that it is freshly available all year round in a great variety. Its remarkable nutritional values make dried apple products become an excellent option for the replacement of traditional snack products, which contain a high level of fat and salt.

Dehydration – which is one of the oldest preservation methods – helps to preserve foods and extend the shelf-life of the products without the addition of chemical substances. Conventional drying at high temperature and for a long time causes significant nutritional and sensorial (e.g. flavour, colour, aroma) damages in fruits and vegetables (*Drouzas et al.*, 1999; *Drouzas & Schoubert*, 1996; *Lin et al.*, 1998; *Mousa & Farid*, 2002). To avoid these losses, microwave (MW) drying is a promising option. The single MW drying has some drawbacks, which include uneven heating, possible texture damage and limited product penetration of the microwave into the product (*Zhang et al.*, 2006); this can be solved by its combination with other methods like vacuum drying.

Consumers' product choices are often influenced not only by the attributes of the product, but also by the method based on which the product was produced, including factors such as origin, working conditions and production technology (*Grunert et al.*, 2004; *Nielsen et al.*, 2009). Studies about the level of worry regarding MW treatments are limited; however, it can be stated that – even though it has been used in the households for a long time – it evokes a moderate concern (*Cardello*, 2003).

Consumer acceptance of dehydrated products depends on characteristics such as structural, textural, sensorial, microbiological and rehydration properties (*Giri & Prasad*, 2013). Several studies show that – compared to conventional dried products – MW vacuum-dried products result in better sensorial characteristics, such as colour or flavour (*Ferenczi et al.*, 2012; *Giri & Prasad*, 2013; *Maskan*, 2002), as well as crisp and porous texture (*Ferenczi et al.*, 2010;

*Krulis et al.*, 2005), contrary to the undesirable hard-crust surface formed by the traditional hot-air (HA) drying (*Li et al.*, 2011).

Therefore, the aim of this study was to analyse the consumers' acceptance regarding the MW vacuum-dried apple pieces compared to an HA-dried slice product.

## 2 Materials and methods

### Conjoint analysis design

In order to get detailed information on the consumers' willingness to buy and their preference of MW vacuum-dried apple piece products – compared to the HA-dried apple slice products currently found on the market –, a conjoint analysis combined with sensorial analysis was done among Hungarian consumers over 18 years in the autumn of 2013. The conjoint analysis is a technique which helps to determine the relative importance of the product characteristics and the utilities of the different levels of the characteristics according to the consumers (*Hoffmann et al.*, 2000). For the conjoint analysis, three product characteristics were used: the “appearance” (emotional characteristic), the “applied technology” as well as the “price”. All characteristics had two levels (*Table 1*). The selection of characteristics was explained by the fact that the HA-dried apple slice product had already been on the market, while the MW vacuum-dried apple piece was a new product developed in the pilot plant of the NARIC FSRI (National Agricultural Research and Innovation Centre – Food Science Research Institute). As for levels of the “price,” an average (based on market data) (200 HUF, approx. 0.6 EUR) and a +20% price was taken into account, and this can be justified by the extra cost of MW technology compared to the price of dried-apple slice products present on the market. All of the created model products (cards) appeared in 50-g packages.

Table 1: Levels of the analysed product characteristics

Product characteristic	Level 1.	Level 2.
Appearance	Piece	Slice
Applied technology	Microwave vacuum drying	Hot-air drying
Price	Average	Average+20%

In the questionnaire, first, the applied technologies were demonstrated in form of a short definition (*Figure 1*); then the participants were asked – in the possession of the technological information, without tasting – to decide which dried-apple product they would have liked to buy. Since the appearance and the sensorial attributes in this case were not relevant, two cards were shown for the respondents: MW vacuum-dried apple slices in a 50-g package for an average+20% price (product developed in the pilot plan), and HA-dried apple slices in a 50-g package for average price (product already present on the market). If the participants were not able to decide between the two products, they could choose “both”.

**Hot-air drying:** is a traditional method which removes the whole humidity content of the fruit with the circulating of hot and dry air.

**Microwave vacuum drying:** is a two-step method in which, at first, the product is partly dehydrated, then the remaining humidity content is removed with low pressure (vacuum) microwave heating. This is a considerate method because of lower heat loading.

Figure 1: Definitions of the applied technologies

As the next step, respondents were asked to taste the two samples (microwave vacuum-dried piece and hot-air dried slice) and to decide on a 1 to 7 Likert scale – in the case of each card respectively – how likely they would have bought the model product (1: not likely at all; 7: very likely). Both of the tasted samples were produced from the same raw material (Idared, *Malus domestica*); however, the technological methods were not presented for the participants; thus, their benefits could not be consciously linked to the samples. For the conjoint study, eight cards were formed with the help of the orthogonal design of the SPSS statistical software and the created cards were set out in a fixed order.

Furthermore, in the questionnaire – in order to get acquainted with the marketing opportunities –, respondents were invited to evaluate the consumption possibilities of potato chips and dried apple products as well as some socio-demographic questions were asked. The final conjoint questionnaire was developed after two group interviews (six participants respectively). After the random asking of people, 420 evaluable questionnaires were collected. For the data analysis, univariate (frequency) and multivariate (cluster analysis) methods and conjoint analysis were done with the help of the SPSS statistical software.

## **Participants**

Regarding the respondents' socio-demographic distribution, it can be said that more females (61.9%) participated than males (38.1%). More than half of the respondents (54.1%) were between the age of 25 and 44 years and most of them were inhabitants of the capital (40%), while fewer of them were from small cities (14.8%). More than two-thirds of the samples were highly educated people (66.7%). Less than half of the participants had children over 18 years of age and almost three quarter of the sample (72.5%) answered that they live under average circumstances. 26% of the respondents consume potato chips only 1–3 times or less often, while 34.1% of them consume dried fruit or vegetable products.

## **3 Results**

### **Willingness to buy dried apple products without tasting them**

Having understood the technological definitions without tasting the samples, the participants were not able to decide unambiguously which product they would have liked to buy. 37.6% answered that they would have bought the HA-dried apple slices in a 50-g package for average price, 32.9% the MW vacuum-dried apple slices in a 50-g package for average+20% price and 29.5% both foodstuffs.

### **Willingness to buy dried apple products after tasting – conjoint analysis**

Following the “piece” tasting (MW vacuum-dried), appearance had a significantly more positive influence on the respondents' shopping decisions than the “slice” format (HA-dried). Significant difference was not observed between the utilities of the “applied technology” levels, while the higher price resulted negative utility values.

Regarding the relative importance data, the “applied technology” was the most important factor influencing the participants' shopping decisions (*Table 2*).

After the tasting and the judgment of the cards, respondents were asked to decide which product they preferred (piece/slice/both/none of them). More than half (60.3%) of the participants preferred the “piece” product and 21.5% the “slice” one. 16.5% of the tasters were not able to make any difference and only 1.7% did not like the tasted samples.

Table 2: Relative importance of each product characteristic and utility values for each level

Product characteristic	Level	Utility	SE	Relative importance (%)
Appearance	Piece	0.167 <sup>a</sup>	0.043	32.924
	Slice	-0.167 <sup>a</sup>	0.043	
Applied technology	MW vacuum drying	0.007	0.043	41.815
	HA drying	-0.007	0.043	
Price	Average	-0.349	0.085	24.546
	Average+20%	-0.699	0.170	

<sup>a</sup> Significant differences between the levels of the characteristic according to paired t-test ( $p < 0.05$ )

### Cluster analysis

For the exploration of the differences among the shopping preferences and for the formation of homogenous consumer groups with the help of the utility values, cluster analysis (K-mean) was done. This resulted four significantly ( $p=0.000$ ) different and well-explainable groups. The “applied technology” ( $F=482.362$ ) had the strongest effect on the cluster creation, while “price” ( $F=12.439$ ) the weakest one. The respondents’ price-sensitive attitude appeared – more or less – in the clusters, too. Utility vales and relative importance data are shown in figures 2 and 3.

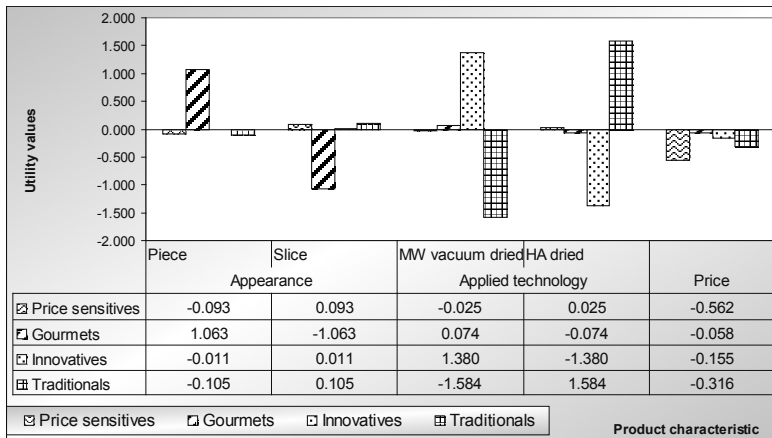


Figure 2: Cluster utilities of each level

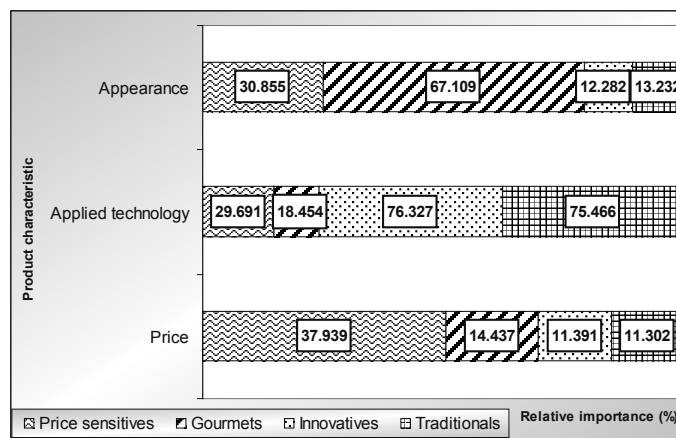


Figure 3: Relative importance of each product characteristic based on clusters

#### Price sensitives (N= 198)

Most of the participants belong to this cluster. For these consumers, “price” is the most important product characteristic influencing their dried-apple-product-shopping decisions, while “appearance” and “applied technology” have almost the same importance. Utility values show the price-sensitive attitude of these cluster members.

#### Gourmets (N= 90)

During the shopping decisions of the second biggest cluster members, “appearance” has an outstanding role. “Piece” appearance has a strong positive effect on their intention. “Applied technology” is not a dominant characteristic for them, and the participants of this cluster showed the lowest price sensitivity.

#### Innovatives (N= 71)

“Applied technology” has a prominently high relative importance, while “appearance” and “price” have more or less the same role in their shopping decisions. Members of this cluster do not feel aversion towards the “MW vacuum drying”; on the contrary, it has a positive impact on their intention. “Appearance” was less important; however, “price” is a relevant factor for them.

### Traditionals (N= 61)

“Applied technology” – as in the case of the “innovatives” – is a highly important characteristic for the members of this cluster. However, as the smallest cluster, its participants reject the “MW drying” technology and prefer the “HA-dried” apple products.

“Traditionals” do not only show aversion towards the technological innovations, but their willingness to pay is also low.

## Consumption possibilities of dried apple products

The consumption possibilities of the dried apple products were found to be more varied than that of the potato chips. Respondents can imagine dried apple consumption during a journey or travelling, watching TV, as snacking, crunching for children, for slimming diet, for guests as well as for adding to the muesli. Participants could not imagine the consumption of any of these products in the cinema, neither as a small meal nor as a composition of dishes (*Table 3*).

Among the other opportunities, some allusions were made at snack in kindergarten and primary schools, during working schedules, and it can also be taken into account as decoration for cakes.

Table 3: Consumption possibilities of dried apple and chips products

	<b>Dried apple</b>	<b>Potato chips</b>	<b>Both</b>	<b>None of them</b>
During a journey or travelling	50.5%	10.2%	13.1%	26.2%
During watching TV	35.2%	17.4%	21.0%	26.4%
Snacking during the day	50.7%	6.9%	8.1%	34.3%
For children to crunch	69.5%	4.3%	5.2%	21.0%
As a small meal	30.5%	4.8%	3.6%	61.2%
For amusement	32.9%	14.3%	28.6%	24.3%
For dishes as a component	27.9%	2.4%	1.4%	68.3%
In cinema	14.3%	19.8%	7.1%	58.8%
For slimming diet	55.5%	1.7%	1.4%	41.4%
For morning muesli	62.1%	2.9%	1.9%	33.1%



## 4 Conclusions

Results of the study showed that the “applied technology” has an outstanding importance during respondents’ dried-apple-shopping decisions. At the same time, the utility values did not show significant differences between the two treatments, what is due to the diversification of the opinions. Based on the creation of homogenous consumer groups, it can be highlighted that the “applied technology” was the most important product characteristic in the dried-apple-shopping decisions of the “traditional” and the “innovatives” clusters. The “innovatives” strongly accepted the utilization of “MW vacuum drying”; however, the “traditionals” rejected it.

“Appearance” – and, in this way, the sensorial attributes of the samples produced from the same raw material – influenced notably the willingness to buy. The puffy and crispy texture of the MW vacuum-dried apple pieces were favourable characteristics – mainly for the members of the “gourmet” cluster – compared to the slightly dry texture of the HA apple slices. On the basis of these results, an outstanding attention is needed for the familiarization and tasting of these products during the launching of the MW vacuum-dried piece version. The presentation of the product in the ambience preferred by the consumers (e.g. trip, travelling, watching TV, snacking, for slimming diet, children and guests) can result further advantages. It is important to note that even though the “price” did not result high importance during the shopping decisions, respondents showed price-sensitive attitude – mainly the members of the “price sensitive” cluster – and this has to be taken into consideration during the product development.

The “applied technology” was not connected to the tasted samples; thus, the judgment of the technology can be evaluated separately from the sensorial characteristics. Based on this, it can be stated that the “applied technology” has a remarkable importance. Results of the present study pointed out that the MW vacuum-dried apple piece product possesses a strong supporting group: the “gourmets,” who showed high emotional preferences and low price sensitivity, as well as the “innovatives,” who could be – after a better recognition of the favourable characteristics – potential purchasers of this new product family.

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