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CONSUMER PERCEPTION ON FOOD WASTE MANAGEMENT AND INCORPORATION OF GRAPE POMACE POWDER IN COOKIES

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Abstract

The aim of this study was to investigate the consumers' attitude towards the use of food industry waste in newly formulated cookies as well as the consumers' acceptance of these cookies incorporated with grape pomace powder (GPP). Total of 13 varieties of cookies were evaluated by sensory trained panel using hedonistic analysis including an attitude survey. Cookies were prepared with dried grape skin and seeds milled into powder as a replacement for the flour. Four different concentrations (2.5, 5.0, 7.5, and 10.0 %) of GPP with 3 different granulations (0.25, 0.50, 1.00 mm) were prepared and compared to the control sample (without GPP). More than a half of the surveyees are aware of the term functional food and they are eager to try food that contain food waste in it, but unfortunately they are not well informed on how the food waste is disposed and managed. The sensory analysis showed that newly developed cookies are well accepted from the panellists due to their good appearance, likable colour, pleasant aroma and taste with those that contain GPP in granulation 1.00 mm being the best ones.

Key words**:** *grape pomace, granulation, consumers' acceptance, consumers' attitude, cookies*

INTRODUCTION

Food industries create large amount c.a 3 billion tons of waste and by-products each year. Part of this waste is exploited and valorized as animal feed, yet large quantities are disposed on the landfill [11]. If not properly managed its uncontrolled decomposition contributes to a significant contamination of the environment which also creates great economic problems with costs associated to their management reaching tens of millions of euros [13, 39]. Therefore, it is essential to explore other alternative ways for food processing waste application. Food waste coming from agro-industries has an enormous potential to be valorized and recycled in new valuable products if it is supported by extensive information about its functionalities. It is known that this type of waste contains significant amounts of valuable components (proteins, dietary fibers, biologically active compounds, antioxidants, polyphenols, etc.) that remain unused [39]. These compounds can be used as health promoters, texturizers, colorants, natural food additives, antimicrobial components, dietary supplements, nutraceuticals etc. [14].

According to the FAO report, 45% of the total waste is generated during the processing of fruits and vegetables. Grape (*Vitis vinifera* L.), as the largest fruit crop with the worldwide production estimated around 23.5 million metric tons, is used as fresh fruit (table grape) and processed in wine and grape juice [32]. Methods for grape juice and wine production are very different, but in both processes the solid waste is composed from stalks, stems, skins, seeds and liquid waste (wash water, cold water and cleaning chemicals) [38]. The solid by-product called grape pomace or grape mark represents rich source of phenolic compounds that demonstrate antimicrobial and antioxidant properties [4]. Many recent researches were focused on characterization of the chemical

composition of the solid by-product like grape pomace, which has proven as worthy source of different high-value ingredients and their application in food industry and cosmetics, having nutritional, economic and environmental benefits at the same time [33]. The grape pomace is composed of dietary fiber (50-75% of total dry matter), protein (12%), oil (7-12%), and soluble sugars (3-4%), while grape stems contain dietary fiber (77%), protein (7-8%), oil and soluble sugars (1.6 and 1.7%, respectively). In respect of phenolic compounds grape pomace contain 4-5% with main aspect on catechins (proanthocyanidins) and glycosylated flavonols, whereas the stem has twofold higher phenolic content with flavonoids (catechin, epicatechin, epicatechin-3-O-gallate, proanthocyanidins, quercetin, and their glycoside derivates) as main compounds [38]. The anthocyianin and polyphenolic content in the grape pomace depend on the production method and contact time between the juice and the solids and represents crucial information for the market potential application and profitability.

Grape pomace has found its way on the market in different forms. It can be sold as dried organic grape pomace supplement that can be added to smoothies and substitutes for yeast in bread making or as grape seed oil [10]. Large portion of grape pomace is recycled back into the vineyard as compost based on aerobic microbial decomposition [5]. More profitable but still theoretical applications of grape pomace have been proposed in biosurfactant production due to their emulsifying abilities and lower toxicities than the synthetic biosurfactants [28]. Another application of the grape pomace is in the production of pullulan – an exopolysaccharide that can be added to food to increase texture and provide low-calorie bulk [27]. Grape pomace is widely used as antioxidant internally to preserve food especially in meat and meat products [29]. The health benefits coming from the dietary fiber aid the application of the grape pomace in powder-containing products in different concentrations or tea infusions made from grape pomace skins [2, 9].

Cookies and baked goods are affordable, long lasting commonly consumed snacks that vary in taste and texture. In addition to this, they can easily be enriched with grape pomace flour and be transformed in functional products with higher content of dietary fibers and bioactive compounds [16].

The food industry waste incorporation in the existing products may encounter several problems. Initially, there is the need for a new product development, followed by the need of adaptation of the technology and additional processing of the waste to prevent it from rapid deterioration due to autolytic, chemical and microbial spoilage [39]. Finally, the last problem arises from consumer's perception of having food that includes biological waste within. In this regard, product information is important key factor that have an impact on consumers preference of the product cause it can produce certain expectations about the product that might affect its sensory evaluation [9]. If the information of positive health benefits is provided, less desired products are better accepted especially if that information is provided at the stage before consumption of the product [8].

In the literature there are many scientific papers on grape pomace incorporated in baked goods such as cakes [22], muffins [26], bread [20], cookies [2], but there was lack of research on the consumers' opinion about the biological waste that the wine industry creates and its incorporation in food. Other authors have also studied and presented enrichment of food products with grape pomace. San'Atnna et al., 2014 [30] have conducted studies of fettuccini pasta in which they have added 25, 50 and 75 g/kg of grape marc powder. They have concluded that fettuccini pasta with added 25 g/kg of grape marc powder has got the best sensory qualities. Tseng et al., 2013 [37] have studied adding of grape pomace in yoghurt and salad dressings and have found that yoghurt with 1% grape pomace, Italian dressing with 0.5% grape pomace and Thousand Island dressing with 1% grape pomace have the best results for sensory analysis. Sudha et al., 2013 [36] have also done sensory analysis of food products enriched with by-products. They have studied

muffins with 8%, 16% and 24% apple skin powder (ASP) and have come to the conclusion that the muffins containing 24% ASP have got the best sensory characteristics. Sudha et al., 2007 [35] have done a sensory evaluation of a cake in which some apple pomace has been added. According to them the best results are gained when about 20% of the wheat flour is replaced with apple cake.

The aim of this study was to conduct a survey on consumers' attitude towards the use of the food waste in development of a new product and the impact of the granulation of grape pomace powder on the hedonistic acceptance of cookies enriched with this kind of waste.

MATERIALS AND METHODS

Questionnaire and test participants

Questionnaire methodology was used to reach the objectives of this research that was available on the Google platform. The questionnaire was consisted of 10 questions including the socio-demographic ones (gender, age, education). The aim of the survey was to see how well consumers are informed about the food waste management, are they informed about food products containing food waste and whether they would consume such. Separately, the surveyees were given newly developed functional cookies enriched with by-products from wine industry. The survey was conducted with 120 people, form urban city area, elected randomly in Skopje region, R.N. Macedonia.

Sample preparation of GPP

Grape skin, seeds and stems (variety: Vranec) were obtained from the grape juice production industry immediately after pressing the juice. Fresh grape pomace was dried at 50°C for 24 h and milled to obtain powder. The grape pomace powder (GPP) was sieved through 1.00; 0.50 and 0.25 mm pore sized sieves and the three granulations were included in cookie preparation as a partial replacement of the flour.

Cookies preparation

The functional cookies with GPP were prepared at the laboratory for food and biotechnology within Faculty of Technology and Metallurgy in Skopje, N. Macedonia. They were prepared according to the method 10-50D [1]. Total of 13 different recipes were prepared including: control (with 0% GPP) and each granulation (1.00; 0.50 and 0.25 mm) was included in the different concentrations (2.5; 5.0; 7.5 and 10.0%) in the cookie formulation.

Sensory analysis

The sensory analysis method was conducted using the method of Nakov et al., (2016) [25] where each of the attributes: colour, appearance, aroma, taste and texture were evaluated separately. Sensory analysis of new enriched cookies was made according to the guidelines on Ethics and Food-Related research defined by the European [3]. Each consumer panellist was given small pieces of 13 distinct cookies alongside with water to rinse their mouth after consumption. The sensory analysis was conducted during daylight and the cookies were coded for objective evaluation. The information that the cookies contain food waste from the industry was shared with the panellists prior the evaluation. They also had brief training on how to evaluate each attribute.

RESULTS AND DISCUSSIONS

The socio-demographic status of the consumer panel is presented in Table 1. It can be observed that 79.17% were female, while 20.83% were male surveyees. Most of them (45%) were at the age between 18 and 30 years, very similar percentage (44%) were at the age between 31 and 60 years and only small fraction (11%) were over 60 years old.

Table 1. Socio-demographics status of the consumer panel

		Number of surveyees	%
Sex	Male	25	20.83
	Female	95	79.17
Age	under 18	0	0.00
	18-30	54	45.00
	31-60	53	44.00
	over 60	13	11.00
Education	Primary	0	0.00
	Secondary	48	40.00
	Higher	68	56.67
	Ph.D	4	3.33

Source: Own calculation.

The cookies are targeted for any age, but the surveyees younger than 18 weren't included in this study because no volunteers were recruited for the consumer panel.

In terms of education, the majority of correspondents (56.67%) had higher education (university degree), 40% were with high school, while only 3.33% had Ph.D degree.

The biological waste that is created from food industries can be used by the same industry or disposed by a third party. The answers of the surveyees responding to the question "Do you know where the biological waste coming from the food industry ends up?" are presented in Figure 1.

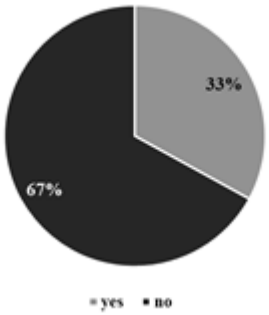

Fig. 1. Answers to the question "Do you know where the biological waste coming from the food industry ends up?"
Source: Own results.

Figure 1 shows that 67% of the respondents are not familiar with where the waste from the food industry ends up, while 33% of them are aware of how the food waste is managed. Due to this high percentage of uneducated consumers, it is necessary to intensify the education of population about this part of the food industry. In Europe, the average level of food waste is 180 kg per person. This high amount of waste coming from the food industry is due to the different cultures and lifestyles of the people inhabiting the continent [6]. Valorisation of by-products of fruit and vegetables would make bioeconomics more circular and would help to reduce high influence on the environment [17]. On the other hand, almost all waste from food industry contains significant nutritional and bioactive substances which can be used for the production of new products in different sectors (food, pharmaceutical and cosmetics). Beside this, waste from food industry very often ends up as a final waste so its further processing is not economically justified. Thus, it is necessary to make a good assessment of economic viability if certain waste is being processed [31].

The answers to the question "Have you ever consumed cookies with added value or functional cookies?" are presented in Figure 2. From the Figure 2 it can be seen that 78% of respondents consumed value-added cookies, and 22% of them haven't consumed any of this kind. Cookies are a widely consumed common food primarily because of their pleasant taste, variety, low cost and long shelf life [18]. Classic types of cookies that are made from white wheat flour contain a large amount of fat, sugar and calories, but little dietary fiber, vitamins, minerals and bioactive substances [15]. However, nowadays demand for nutritionally enhanced and functional products is growing. These products are produced by replacing and/or adding flour to the recipe that has better nutritional properties than white wheat flour. This improves the content of dietary fiber and bioactive substances that have health benefits [34].

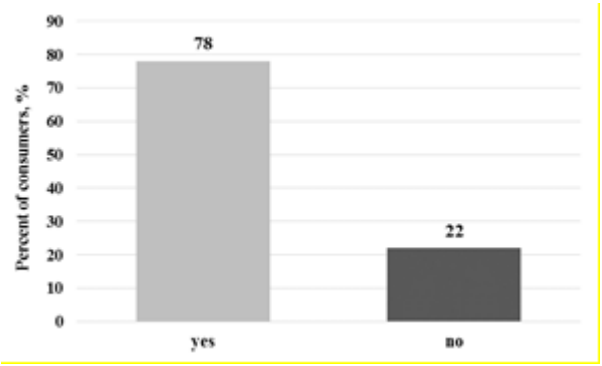

Fig. 2. Answers to the question "Have you ever consumed cookies with added value or functional cookies?"
Source: Own results

The answers to the question "How often do you eat cookies?" are presented in Figure 3. The same percentage of respondents (11%) answered that they do not consume cookies at all or they consume them 2-3 times a week, while none of the respondents (0%) consume cookies every day. In addition to this, the

highest percentage of respondents (78%) answered that they consume cookies 2-3 times a month (Figure 3). In a survey from the previous year conducted in 3 countries (Macedonia, Bulgaria and Croatia) on the question what do you most often consume from grain products, in all three countries the first product is bread, while respondents from the Republic of Macedonia ranked cookies in third place in terms of consumption [21].

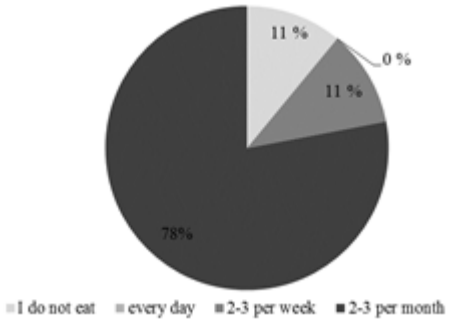

Fig. 3. Answers to the question “How often do you eat cookies?”
Source: Own results

In the questionnaire, the question "What is the most important to you when choosing cookies?" was also asked.

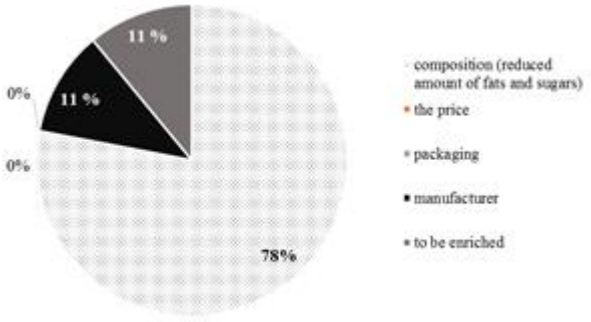

Fig. 4. Answers to the question "What is the most important to you when choosing cookies?"
Source: Own results

For 11% of the surveyees it is important that the cookies are enriched with added-value substances, the same percentage answered that the brand of the product plays an important role, while for 78% of respondents the composition (ingredients) of the cookies is imperative. On the other hand, for the surveyed consumers, the price and packaging (0%) of the product are absolutely irrelevant (Figure 4).

Recently, consumers are progressively paying more attention to the information presented on the packaging of food products. Figure 5. presents the answers to whether the information written on the packaging of food products is important. About two-thirds (67%) of the surveyees believe that it is important to have adequate information about the nutritional composition and energy value of cookies on the packaging. Nakov et al., (2017) [23] conducted a research on the manner of labelling of food products in the Republic of Macedonia and concluded that consumers most often read the information given on the label, when buying a food product. Among the problems consumers face, they give the small font of letters and the use of many signs and numbers (marked as "E"). When choosing the price, the consumers chose the products with longer shelf life.

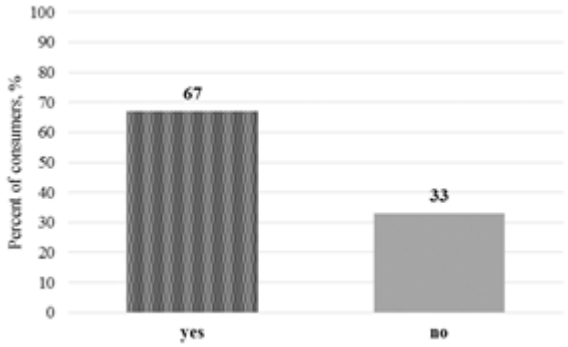

Fig. 5. Answers to the question “Is the information written on the packaging of food products important?”
Source: Own results

Figure 6 represents the answers to the question "Do you know what functional cookies are?"

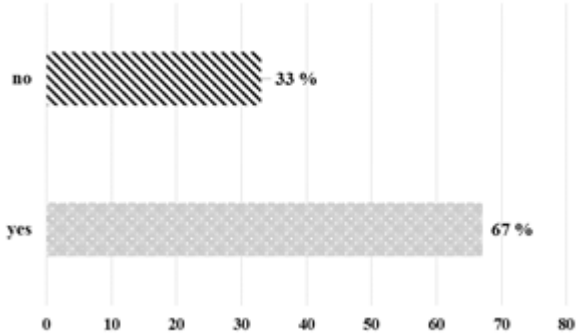

Fig. 6. Answers to the question "Do you know what functional cookies are?"
Source: Own results

33% of the surveyees answered that are not familiar with the definition of functional cookies, while 67% had an opinion about the meaning of functional cookies. In addition, those that responded affirmative to the previous question were kindly asked to give their opinion to what functional cookies are. Some of the given answers are presented in Figure 7.

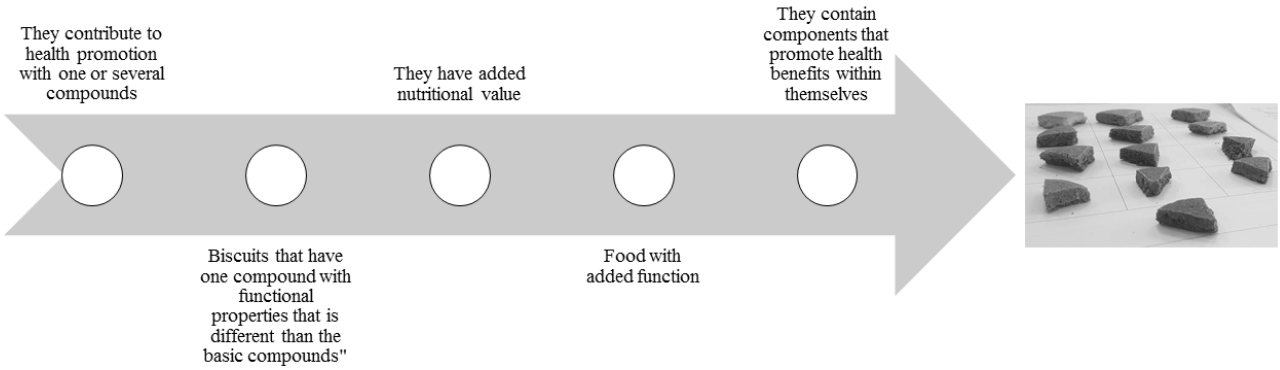

Fig. 7. Answers to the question "What is the definition of functional cookies?"
Source: Own design.

There are different definitions of functional food. The food that has positive influence on one or many functions in the human organism, aids the development of intellectual and physical capabilities, reduces the risk of different diseases and improves the overall health can be called functional food [24, 7].
In Figure 8 the answers of the question "Would you eat cookies that have food waste in their formulation?" are presented.

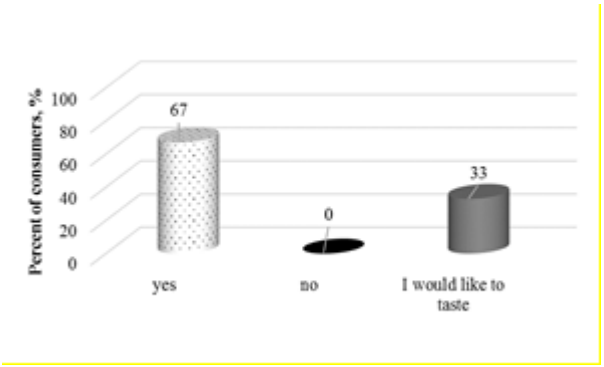

Fig. 8. Answers to the question "Would you eat cookies that have food waste in their formulation?"
Source: Own results

From the results presented on Figure 8 it can be noticed that 67% from the surveyees would consume cookies with grape skin and seed powder, 33% would like to try this kind of a product and none of them wouldn't consume cookies with food waste. Weather one newly developed functional product will find its place on the market depends on numerous factors. These include the price, the acceptability from the consumers, as well as the economic viability throughout its production [12]. In the recent years there is a trend in the research and production of food products incorporated with food by-products, which influence the technological, nutritional, health and sensorial properties [19]. Sensorial properties of food are closely tied with the hedonistic feeling that it provides during the consumption via the attributes that can be determined with the senses of sight, smell, taste and touch. These properties are usually the unique parameters according to which the consumers make a decision whether they shall buy the product or not [25].
In Figure 9 the appearance of the cookies incorporated with GPP in different granulation (1.00; 0.50 and 0.25 mm) and different concentration (2.5; 5.0; 7.5 and 10.0%) are presented. Total of 13 cookies (including the control) were sensory evaluated.
The results from the sensory analysis of the cookies enriched with grape skin and seeds powder added in different concentration and granulation are presented in Table 2.

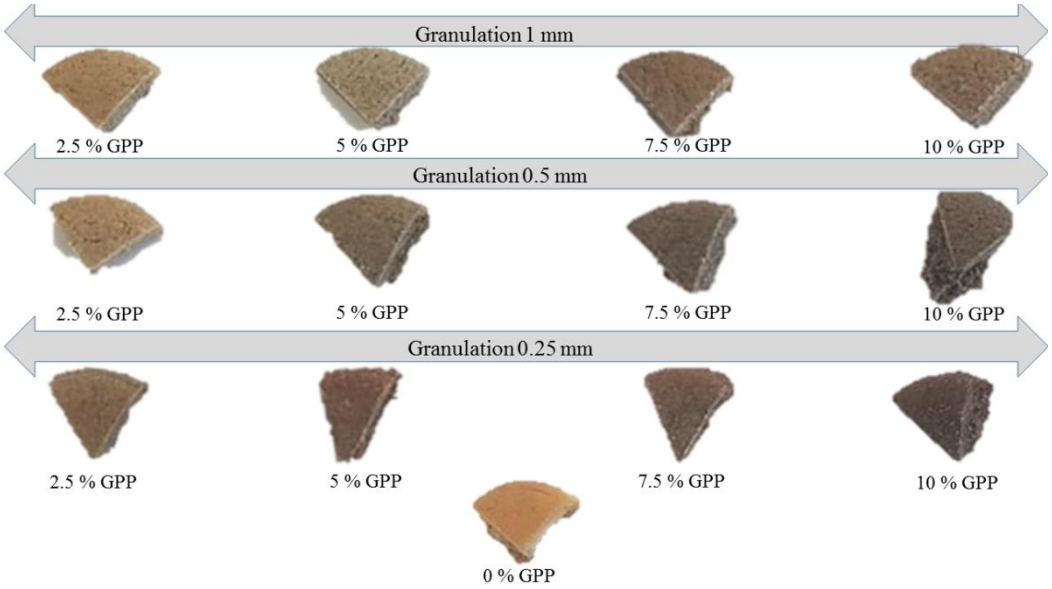

Fig. 9. Cookies with different granulation and different concentration
Source: Own design.

The results from the sensory analysis of the cookies enriched with grape skin and seeds powder added in different concentration and granulation are presented in Table 2.

Table 2. Sensory analysis of enriched cookies with GP

		Colour	Appearance	Aroma	Taste	Texture
Control		8.00 ± 0.12	7.70 ± 0.23	7.22 ± 0.90	6.55 ± 0.39	7.55 ± 0.77
Granulation 1.00 mm	2.5 % GPP	6.00 ± 0.21	7.00 ± 0.36	7.44 ± 0.24	7.66 ± 0.22	8.00 ± 0.45
	5 % GPP	6.00 ± 0.32	6.50 ± 0.54	6.66 ± 0.23	7.66 ± 0.57	8.00 ± 0.21
	7.5 % GPP	5.60 ± 0.17	7.00 ± 0.32	6.88 ± 0.38	6.88 ± 0.66	7.88 ± 0.69
	10 % GPP	5.70 ± 0.54	6.33 ± 0.37	6.55 ± 0.47	7.11 ± 0.75	7.22 ± 0.38
Granulation 0.50 mm	2.5 % GPP	6.50 ± 0.45	6.55 ± 027	7.11 ± 0.65	6.88 ± 0.87	7.44 ± 0.55
	5 % GPP	6.20 ± 0.36	6.66 ± 0.80	7.44 ± 0.35	7.33 ± 0.33	7.55 ± 0.58
	7.5 % GPP	6.00 ± 0.24	6.66 ± 0.58	7.00 ± 0.33	6.88 ± 0.36	7.00 ± 0.32
	10 % GPP	6.70 ± 0.35	6.11 ± 0.96	6.88 ± 0.29	7.00 ± 0.41	6.77 ± 0.41
Granulation 0.25 mm	2.5 % GPP	6.60 ± 0.032	6.77 ± 0.12	7.33 ± 0.56	7.33 ±0.52	6.55 ± 0.44
	5 % GPP	6.80 ± 0.19	6.55 ± 0.39	7.88 ± 0.59	7.66 ± 0.84	6.55 ± 0.63
	7.5 % GPP	7.25 ± 0.47	6.66 ± 0.28	6.25 ± 0.92	6.55 ± 0.11	5.88 ± 0.95
	10 % GPP	7.87 ± 0.63	7.33 ± 0.25	6.55 ± 0.36	6.88 ± 0.85	5.11 ± 0.89

Source: Own results.

From the presented results it can be noticed that the control samples for the attributes colour and appearance were evaluated with the highest scores (8.00 and 7.00, respectively). In the other hand, if the average scores for the same attributes for the cookies with different granulation were to be compared; those that were incorporated with 0.25 mm GPP got the highest average score (7.13 and 6.23, respectively). Cookies that have the best aroma were those incorporated with 5% GPP in 0.25 mm granulation (7.88). When the attribute aroma is compared within the cookies with different granulations, those that were produced with grape pomace powder in granulation 1.00 mm had an average score of 6.88, cookies that had grape pomace flour with granulation of 0.50 mm in their formulation were evaluated with average score of 7.11, while the ones that contained

grape pomace flour in granulation of 0.25 mm scored 7.00 as an average. In terms of taste, the best scores (6.88) were attributed to the cookies that were incorporated with 10% of grape pomace flour with granulation of 0.25 mm. Cookies that contained grape pomace flour in granulation of 1.00 mm in different concentration were evaluated as the tastiest (7.33). The texture was estimated as the best in the cookies that contained 2.5 and 5 % grape pomace flour with granulation of 1.00 mm. Furthermore, cookies in this group (granulation of 1.00 mm of the grape pomace flour) obtained the highest overall score (7.76) for the texture.

The last question in the questionnaire was whether the panelists would buy the cookies that were evaluated in the sensory analysis and why?

From the answers (data not shown) all of the consumers would buy the newly developed cookies enriched with grape pomace powder in different granulation and added in different concentration. Some of the reasons why they would choose to buy the evaluated product were presented in Figure 10. Among other things the panelists stated their satisfactory colour, aroma, flavor, the excellent aftertaste and because they are nutritionally richer than the traditional cookies. On the other hand, part of the panelists will decide to buy this kind of a product because of their higher ecological awareness and the fact that the product includes food waste. They also liked the appearance of the cookies which is certainly one of the most important factors in making decisions.

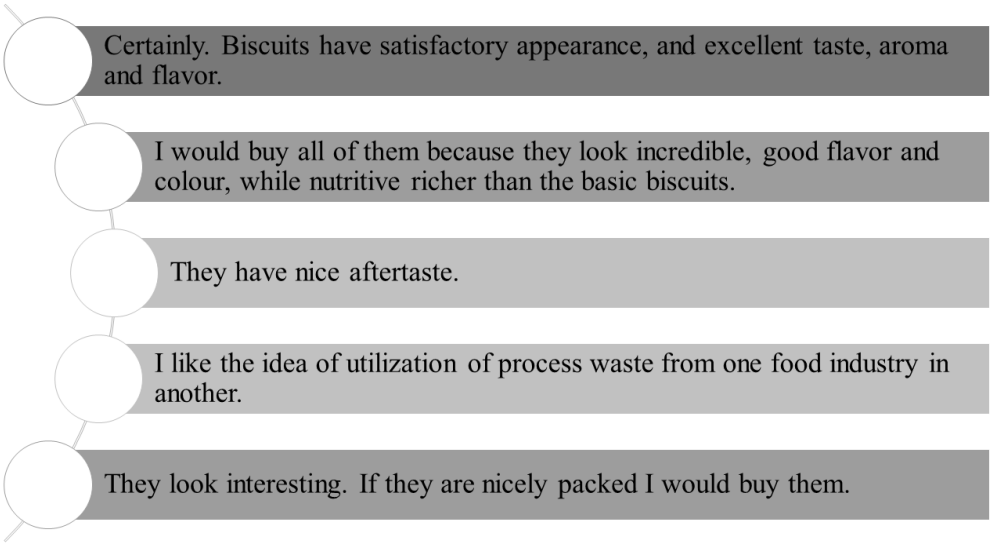

Fig. 10. Some of the reasons why the consumers would buy the enriched cookies with grape pomace.
Source: Own design

CONCLUSIONS

From the conducted survey it is concluded that the surveyees don't have enough information on the topic about food waste, where it is disposed and how it is managed. For that reason additional education on food waste management, its uses and possible applications in the food industry is of a big necessity. More than a half of the surveyees had already consumed functional cookies and the same fraction would also try cookies that contain food waste in their formulation. The results from the sensory analysis demonstrated cookies incorporated with grape pomace powder with granulation 1.00 mm as the best ones.

Newly developed cookies would be bought due to their good appearance, likable colour, pleasant aroma and taste, the fact that they are nutritionally richer than the traditional ones and they contribute to the environmental pollution reduction by containing food waste within.

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