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ARTICLE

Sensorial analysis of a functional beverage based on vegetables juice

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ABSTRACT Functional food products have become an important segment of food industry. They have been defined as products that provide physiological benefits or reduce the risk of chronic disease beyond primary nutritional functions. The continuous growth of functional food market is a consequence of the increasing interests for products that offering health benefits. The elaborations of new functional products lead to an increasing competition so that the consumer acceptance of the new products is important. The sensorial analysis can provide essential information to obtain a good understanding of consumer food choice. Due to the bioactive compounds contained, vegetables juice can be a convenient medium for the development of a functional beverage. The present study is focused on the consumer acceptance of a fermented juice made from beetroot, carrot and celery. This juice has been inoculated with three probiotic strains: *Lactobacillus acidophilus, Lactobacillus casei* and *Saccharomyces boulardii*. After lactic fermentation, the functional beverage has been evaluated by trained panelists. All the data has been analyzed using *Senpaq* statistical software. **Acta Biol Szeged 57(2):145-148 (2013)**

KEY WORDS

sensorial analysis
vegetables
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The notion of functional food occurred from identification and understanding of potential mechanisms of biologically active compounds in food, which can reduce the risk of disease (Binns and Lee 2010). The definition of functional food proposed by EC Concerted Action on Functional Food Science in Europe (FUFOSE) is: "a food that beneficially affects one or more target functions in the body beyond adequate nutritional effects in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease".

Consumer interest for potential health benefits of a proper alimentation has led to a growing importance of the relationship between diet, specific food ingredients and health (Bornkessel et al. 2014). The alimentation has a major influence on the human well-being, but today's consumers may not have the time to consume their optimal diet. Functional foods can provide a high concentration of ingredients in a proper form.

The principal reason of consumers for purchasing functional foods is the growing desire to use foods in prevention of chronic illnesses. Consumers consider that base product is the most important attribute in selecting of a probiotic functional food and prevention claim is the most valuable (Annunziata and Vecchio 2013). The functional products represent a sustainable trend in food industry. Functional food market is growing worldwide and that increase the competition in this field (Bigliardi and Galati 2013). The success of functional foods is correlated with consumer acceptance of the products as part of the daily diet (Annunziata and Vecchio 2011).

Fermented dairy products are generally good food matrices for development of functional foods, but the consumption of these products is limited due to growing vegetarianism and the large number of individuals who are lactose intolerant or on cholesterol-restricted diets (Martins et al. 2013). A clear orientation toward innovation in adopting a new model followed by a complete strategy of following relevant knowledge and resources through more extensive structures may lead the course for innovative new functional food products in future (Khan et al. 2013). Developing new beverage based on vegetables, which can meets consumer demands and increase vegetable consumption are of major importance. New product development requires detailed knowledge of both the products and the customer choice (Prado et al. 2008). The responses of consumers to the sensory properties of beverage, like flavor, mouthfeel, aftertaste and odor, are determinant factor in determining the acceptance of innovative new products. Thus our study is focused to development of a new functional beverage using sensory analysis as a design tool.

Materials and Methods

Materials

Vegetables juice used for this study was obtained from beetroot, carrot and celery (in ratio 11:5:4). The vegetables were

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Table 1. Experimental design.

Sample	Proportion yeast / bacteria	Amount of inoculum (Log CFU/mL)	Amount of *L. acidophilus* inoculum (Log CFU/mL)	Amount of *L. casei* inoculum (Log CFU/mL)	Amount of *S. boulardii* inoculum (Log CFU/mL)
1	0.6	7	0	4.38	2.62
2	0.6	7	4.38	0	2.62
3	0.2	5	2.08	2.08	0.84
4	0.343	7	2.61	2.61	1.78
5	0.6	4.1716	1.30	1.30	1.5716
6	0.2	7	2.92	2.92	1.16
7	0.0343	5	2.42	2.42	0.16
8	1.1657	4.1716	0.96	0.96	2.2516
9	0.6	4.1716	2.61	0	1.5616
10	0.6	4.1716	0	2.61	1.5616

Table 2. Results of experimental design for all samples after fermentation.

Sample	Proportion yeast /bacteria	Amount of bacteria inoculum (Log CFU/mL)	Amount of yeast inoculum (Log CFU/mL)
1	0.94	9.48	8.95
2	0.85	9.30	7.90
3	0.99	8.30	8.23
4	0.89	8.95	7.98
5	1.09	7.70	8.38
6	0.96	8.90	8.54
7	0.86	8.40	7.20
8	1.01	7.57	7.64
9	1.14	7.00	8.00
10	1.03	8.48	8.77

purchased from a local market. After the preliminary operations like washing, peeling and slicing, the vegetables were juiced with a centrifugal juicer provided by Philips.

Freeze dried *Lactobacillus acidophilus* LA-5 and *Lactobacillus casei* 431 were obtained from CHR Hansen SRL (Brașov, Romania) and directly used as starter culture. *Saccharomyces boulardii* was obtained from Biocodex Laboratories (Montrouge, France). Samples were inoculated by adding bacteria and yeast in different proportion and incubated at 37°C. The fermentations were carried until the pH value of 4.6 was reached (after ca. 6-8 h) and stopped by quick cooling. All samples were stored under refrigerated conditions for 7 days.

Sensorial analysis

Sensory profiles of 10 samples were evaluated in laboratory, by the trained panel of five assessors using the preferential method that is an affective method (Lea et al. 1998). Fermented juice was served in 100 mL portions in white polystyrene cups, labeled randomly with selected codes. These portions were served at room temperature (ca. 20°C) to better differentiate odors and flavors and facilitate the characterization and comparison of each sample. The samples were evaluated on the perceived intensity of 7 attributes (odor, acidity, flavor, mouthfeel, aftertaste, color, general aspect). Subjects evaluated samples on 0-5 line scales anchored at 0 ‘not at all’ at the left end and 5 ‘very’ at the right end.

Statistical analysis

The Unscrambler X software v. 10.1 (CAMO Software, Norway) was used for the experimental design (Table 1). Intensity ratings were collected and Principal Component Analysis was performed using SENPAQ 4.7 (QiStatistics, UK, 2008). PCA is a multivariate statistical method applicable, where there are common descriptors, and enables the visualization of the data in a two- or three-dimensional space, enabling the identification of which samples were the most different and which sensory descriptors were predominantly responsible for those product differences (Mavrommatis et al. 2011).

Results and Discussion

After fermentation of vegetables juice the total CFU for bacteria and yeast was counted (Table 2). A good viability of samples inoculated with *L. casei* was found compared with that inoculated with *L. acidophilus*. All the samples were accepted by the panelists. An important factor that influences negatively the attributes of samples was the acidity caused

Table 3. Average intensity scores of all attributes generated by the sensory panel of all samples. Averages in the same row followed by the same letter are not significantly different at a level of 5% significance.

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
General aspect	3.4[a]	3.8[a]	3.6[a]	4.0[a]	4.2[a]	4.0[a]	3.4[a]	3.8[a]	3.2[a]	3.4[a]
Color	4.0[a]	4.2[a]	4.2[a]	3.6[a]	4.6[a]	4.4[a]	4.0[a]	3.8[a]	3.6[a]	3.4[a]
Odor	2.4[b]	3.0[ab]	2.4[b]	3.4[ab]	4.0[a]	3.8[a]	4.2[a]	3.4[ab]	3.8[a]	3.6[ab]
Acidity	2.4[ab]	1.8[b]	2.6[ab]	3.2[ab]	3.4[a]	3.0[ab]	2.8[ab]	3.2[ab]	2.2[ab]	3.6[a]
Flavor	2.2[c]	3.0[abc]	2.4[bc]	3.4[abc]	3.4[abc]	3.6[abc]	4.0[a]	3.6[abc]	2.6[abc]	3.8[ab]
Mouthfeel	2.8[a]	2.6[a]	2.4[a]	3.8[a]	3.4[a]	3.0[a]	2.8[a]	3.2[a]	2.6[a]	3.8[a]
Aftertaste	2.4[b]	3.0[ab]	2.6[ab]	4.2[a]	3.6[ab]	3.2[ab]	2.8[ab]	3.8[ab]	2.8[ab]	3.2[ab]

by lactic fermentation of vegetables juice. These results are similar with observation of Öztürk et al. (2013).

All the samples were evaluated by trained panelists and average ratings for all samples and attributes are represented in Table 3. The samples inoculated with *L. acidophilus* obtained a better score at attributes odor and color compared with samples inoculated with *L. casei*. Samples with *L. casei* were perceived more acid and the mouthfeel was better that the samples inoculated with *L. acidophilus*. The color scores were highest as compared to mouthfeel, odor, acidity, aftertaste and general aspect of the samples. These observations are similar to that of Daneshi et al. (2013).

As we can see in Figure 1, a good correlation between mouthfeel and acidity of samples was observed. The correspondence found between attributes mouthfeel and aftertaste was equal with that between flavor and odor (0.77). A negative correspondence between color and all other attributes excepting general aspect of samples was observed.

The best average score was obtained by samples inoculated with 1.3 log CFU/mL *L. acidophilus*, 1.3 log CFU/mL *L. casei* and 1.5716 log CFU/mL *S. boulardii* (Sample 5). Samples inoculated with *L. acidophilus* and *L. casei* had obtained a better average intensity scores towards samples inoculated with one of the strains. The best scores for attributes general aspect and color were obtained by sample 5 (Fig. 2). The best mouthfeel and aftertaste were given by sample 4. Sample 10 had the best score for attribute aroma. Reddy et al. (2013) were obtained in beetroot fermented juice higher scores for attributes flavor and color than the scores obtained in our study. The color of the samples achieved a lower score (3.4-4.6) compared to the scores of fermented multi-vegetables juice (4.5-4.83) obtained by Radyko et al. (2006) after 7 days of storage.

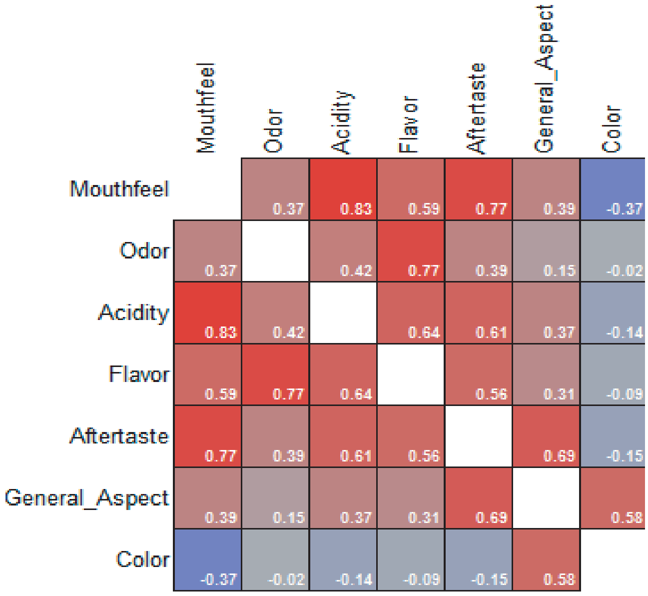

Figure 1. Correspondence between all attributes of samples.

These data were then subjected to principal component analysis (PCA) and the first two principal components explained 75.4% of the variance as shown in Figure 3. These results show that the use of variables is adequate for sensorial evaluation of fermented juices. Principal component PC1 had high loadings on all attributes scores, except color. PC2 had positive loading for color attribute. The bi-plot scores for all samples on the two components were also projected. The samples in the right quadrants were the most liked and were rated as being acceptable for consumers. The positive part of

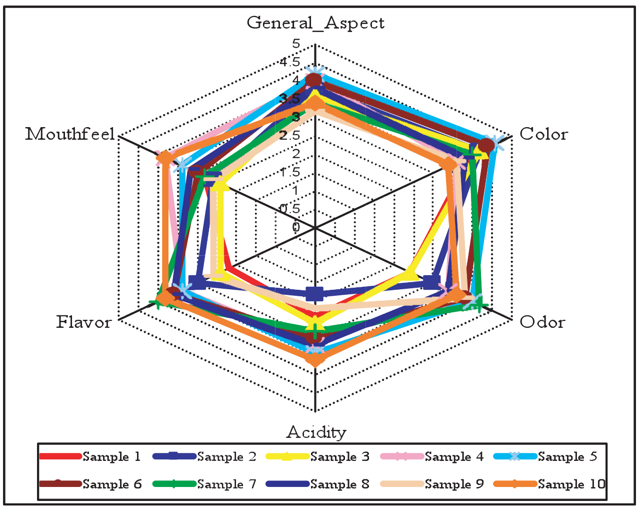

Figure 2. Star diagram for all attributes and samples.

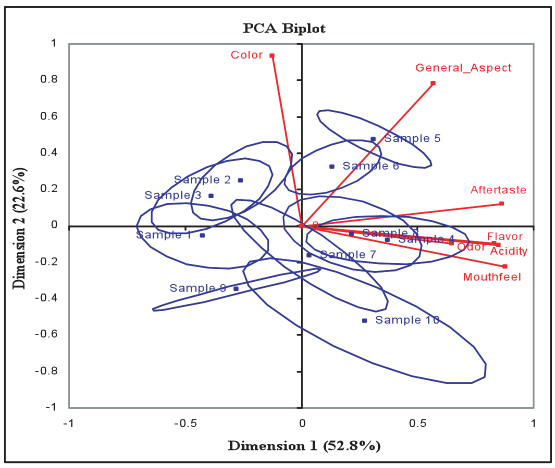

Figure 3. PCA-Bi-plot showing sample mean scores in relation to the attribute loadings on the first two principal components. Ellipses indicate sample confidence intervals.

PC1 and the negative part of PC2 reflected the acid variable. This observation is correlated with the results obtained by Karovičová and Kohajdová (2002).

Conclusions

Sensory analysis is an important instrument for development of new functional products. It can provide a clear understanding of product characteristics, increases researcher confidence in product quality and it identifies the sensory attributes according to consumer preference. Our study demonstrates that affective (subjective) test can give significant information for development of new products. Application of principal component analysis can selected the most important variables an increase the accuracy of sensorial evaluation. Acceptability of products had a major relevance on the functional products market, where the competition is in a continuous growing.

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