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STUDY ON THE ACCEPTABILITY OF YOGHURT WITH CARROT JUICE

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Abstract: *In this paper we focus on the results of a study regarding the evaluation of the sensory characteristics and consumers' acceptance of unsweetened yoghurt with carrot juice. The yoghurts were obtained considering three carrot juice levels (10%, 20% and 30%, respectively) and two starter cultures. Carrot yoghurt was prepared in the laboratory by adding carrot juice to milk and inoculated with a 3% yoghurt culture. The effects of the carrot juice on the sensory quality and consumers' acceptance of the yoghurt samples were determined. The data obtained on various parameters were statistically analyzed.*

Keywords: *yogurt, carrot juice, sensory quality, consumer acceptability, preference map.*

1. Introduction.

Yoghurt is a popular healthful dairy product obtained by fermentation of milk with lactic culture producing fermentation of lactose; the pH decreases due to lactic acid accumulation and coagulation of casein. Yoghurt is a traditional product across the country and for all income segments of population and therefore, its production and consumption has increased in recent years in Romania. The data delivered by the National Institute of Statistics for the years 2003 and 2015 show some evolution in terms of production of yoghurts which stands for a general upward trend in the analyzed interval [1]. Moreover, yoghurt is a product with multiple health benefits since it contains viable bacteria that are considered probiotics and may help adjusting the microflora in the intestines. The addition of fruit or fruit mixtures, fruit flavors and sugar in yoghurt and yoghurt drink improves the nutritional and sensory properties [2]. Several investigations into different additions of fruit, fibers and protein fortifying agents in yoghurt have been conducted. Boycheva, S., *et al.*, 2011, evaluate the effect of goat's milk yoghurt supplemented by aronia and blueberry juice. The results obtained show that the addition of aronia and blueberry juices increased the amount of unsaturated fatty acids in yoghurt by 6.9% and 8.5%, respectively. Polyunsaturated fatty acids increased by 11.2% in yoghurt with aronia juice in comparison with natural yoghurt [3]. Hashim, I. B., *et al.*, 2009 reported that an increase in the acceptance ratings of yoghurt fortified by up to 3% date fiber (DF) was registered as compared with the control yoghurt [4]. A recent study has proposed the direct use of scalding water from quince fruits scalded in a set style yoghurt on yoghurt quality for 28 days of refrigerated storage [5]. The addition of banana marmalade [6], mulberry pekmez [7], ethanol extracts of four different grape varieties (Cabernet Sauvignon, Chardonnay, Shyrah, and Merlot) and grape callus/cell culture [8], sour cherry pulp [9] has also been tested on dairy products. The addition of carrot juice and yoghurt produces a nutritionally balanced food because carrot is rich in beta carotene, ascorbic acid and tocopherol [10]. Carrots (*Daucus carota*) are important vegetables

in diets, being associated with their carotenoids, dietary fibers, vitamins, minerals and bioactive compounds content. Thus, carrots are recommended for improving eyesight, to lower cholesterol and for skin care, in case of nervous disorders or indigestion [11].
In a study on the content of total polyphenols, ß-carotene and antioxidant activity in five varieties of carrots (*Jitka, Kardila, Katlen, Rubína* and *Koloseum*), Bystrická, J., 2015 and others have shown that total polyphenols were recorded in the variety of Koloseum (113.69 ± 11.57 mg/kg), emphasizing that carrot is a rich source of carotenes [12].
Daneshi, M., 2013 investigated the changes of pH, acidity, sedimentation and sensory quality of the milk/carrot juice drink. The scores allocated for colour, flavour, taste and consistency showed that during the first 5 days of the storage period all samples had the highest sensory acceptability [13].
The most important five characteristics of the products to be analyzed in this paper are: taste, color, appearance and consistency of the clove, fat content and whey. Intensity of color, in the case of acidic dairy products, stands for the characteristic color of juice (in the case hereby for that of carrot). Yellow may be interpreted as follows: the product is either too ripened and matured or it got altered, whereas a too intense color in the case of fruit products would mean a higher presence of artificial colorants or chemical chemical additives. Flavor should vary according to the recipe and the sales package data; appearance and consistency of the coagulum: fine, compact or with a fluid consistency like fresh cream, visible coagulum particles are admitted. Taste should be as natural as possible if it is simple, milk, not too pronounced (sour, acidified, pungent, ugly) but pleasant, characteristic, sour, refreshing, odorless or foreign taste. As regards whey, the less they contain, the fresher and better the acidic airy products are**.**
Thus, the aims of this study was to analyze new fruit yoghurts by adding carrot juice to milk and inoculated with a 3% freeze-dried starter yoghurt culture and to determine the effect of different concentrations of carrot juice on their sensory characteristics.

2. Materials and methods.

Materials

Raw cows' milk was obtained from a local milk dispenser in Suceava (Romania). Fat content and pH of this fresh milk were 2.8 % and 6.56, respectively. The freeze-dried starter yoghurt culture (Chr. Hansen Co. (Denmark), FD-DVS CHN-22, containing *Lactococcus lactis subsp. cremoris* and FLORA DANICA, containing *Lactococcus lactis subsp. diacetylactis* ware purchased from SC Enzymes@Derivates SA Romania (Costisa Neamt).

Preparation of carrot juice

Mature carrot samples (cultivars Suceava) were freshly harvested from the field in October 2016.The carrots were washed and manually peeled using a stainless steel knife prior to juicing in a robot type fruit squeezer.

Manufacture of yoghurt samples

Yoghurt was prepared in such a way to contain various concentrations of carrot juice of 10%, 20 % and 30% and it was inoculated by two types of culture. Milk used for the yoghurt production was heated at 85°C for 30 min and then rapidly cooled to 43°C in order to inoculate the starter. After being cooled, the samples were inoculated with FD-DVS CHN-22 type culture (noted as C1), the others were inoculated with FLORA DANICA type culture. The inoculation rate was of 3 % for all samples. Once the starter was completely mixed, it was then incubated at 41-43°C for 3-4 hours to complete the preparation. The fermentation was considered completed when a pH of 4.6-4.7 was reached. For sensory descriptive testing, yoghurt samples were kept under normal refrigeration conditions (4°C) for 24 hours before assessments. Table 1 depicts the different yoghurt samples by percentage of carrot juice and type culture included in the formulation.

Table 1.

Experimental design of yoghurt sensory study for eigh total treatments

Type of culture included	Composition of yoghurt	Cod
FD-DVS CHN-22 (C1)	Control (0% carrot juice)	P0 – C1
	10% carrot juice	P1 – C1
	20% carrot juice	P2 – C1
	30% carrot juice	P3 – C1
FLORA DANICA (C2)	Control (0% carrot juice)	P0 – C2
	10% carrot juice	P1 – C2
	20% carrot juice	P2 – C2
	30% carrot juice	P3 – C2

Methods:

Sensory Evaluation

Twenty semi-trained panelists regularly yoghurt consumers (60% female; 22 – 56 year old) were voluntarily recruited and instructed on how to perform the sensory evaluation by the staff and students of the Faculty of Food Engineering, Stefan cel Mare University of Suceava, Romania. Informed consent was obtained from all the participants. Yoghurt samples were presented in opaque white plastic cups at room temperature (20 ± 1°C). All samples were marked with 3-digit codes, and the order of presentation of samples was randomized for each panelist. The panelists rated general appearance, taste, color, odor, flavor and texture (firmness) using a point hedonic scale (1 point for "*dislike very much"* and 7 points for „*like very much*") [14]. The results of evaluation were written down by all panelists for every sample.

Statistical Analysis

Data sets were evaluated using descriptive statistics for average ± standard deviation. Means of sensorial characteristics were compared by using two-way analysis of variance (ANOVA), in order to assess significant differences among samples.

A two-way ANOVA was used to assess the effects of carrot juice level (10%, 20%, 30%) and bacterial cultures (C1, C2). The threshold for significance was set at $p<0.05$. If significant differences between samples were found, then Tukey's HSD was used to determine which samples differed significantly. A biplot and an external preference mapping (PREFMAP) were represented for sensory and hedonic analysis of samples to compare and to evaluate the interrelationships between attributes for all 6 types of yoghurts (3 carrot juice levels: 10%, 20%, 30% and two cultures C1 and C2). A biplot from the Principle Component Analysis (PCA) is studied to interpret the position of the objects in PREFMAP as a function of the objective criteria. All the analyses were performed by using Microsoft Excel with XLSTAT™ (Trial Version, Addinsoft, U.S.A.).

3. Results and discussion

For the sensory examination, we chose semi-trined panelists regular yoghurt consumers who, on the basis of the tasting sheet and the tasting of the samples presented in Table 1, responded to the questions asked. During the sessions of analysis, the assessors analyze the sensory properties of each sample by objective evaluations. The results of evaluation were written down by every panelist for all samples.

a. b. c.

Fig. 1. Yoghurt samples: (a) control (0% carrot juice); (b) yoghurt with C1 (FD-DVS CHN-22); (c) yoghurt with C2 (FLORA DANICA); where 10% (P1), 20% (P2) and 30% (P3) carrot juice, respectively

The following table shows the sensory qualities for consumers' acceptance of yoghurt with carrot juice. Mean hedonic scores for general appearance, color, taste, odor, flavor and texture (mouth-feel) and overall liking can be found in the table 2.

Table 2.

Scores for sensory attributes for yoghurt samples with juice carrot (0%, 10%, 20%, 30%) and C1, C2 cultures

Yoghurt samples	Taste	Odor	Flavor	Texture (firmness)	Color	Appearance
P0 – C1	$5.20^{a}\pm1.44$	$5.20^{a}\pm1.44$	$5.15^{a}\pm1.39$	$5.80^{a}\pm1.11$	$5.80^{a}\pm1.01$	$6.20^{a}\pm0.81$
P1 – C1	$5.50^{b}\pm1.36$	$5.40^{b}\pm1.47$	$5.40^{b}\pm1.47$	$5.40^{b}\pm1.54$	$5.80^{a}\pm1.06$	$5.80^{b}\pm1.03$
P2 – C1	$5.50^{b}\pm1.36$	$6.00^{c}\pm1.03$	$6.00^{c}\pm1.03$	$5.05^{c}\pm1.73$	$5.70^{a}\pm1.34$	$6.20^{a}\pm1.03$
P3 – C1	$5.75^{c}\pm1.37$	$5.80^{d}\pm1.11$	$5.85^{d}\pm1.09$	$4.55^{d}\pm1.91$	$5.90^{a}\pm1.17$	$6.10^{a}\pm0.94$
P0 – C2	$4.95^{d}\pm1.43$	$5.20^{a}\pm1.44$	$5.15^{a}\pm1.39$	$5.80^{a}\pm1.11$	$5.95^{a}\pm0.95$	$6.10^{a}\pm0.83$
P1 – C2	$5.50^{b}\pm1.36$	$5.40^{b}\pm1.47$	$5.40^{b}\pm1.47$	$5.50^{e}\pm1.43$	$5.80^{a}\pm0.95$	$5.80^{c}\pm0.92$
P2 – C2	$5.50^{b}\pm1.36$	$5.90^{c}\pm1.02$	$6.00^{c}\pm1.03$	$5.05^{c}\pm1.73$	$5.40^{b}\pm1.47$	$6.10^{a}\pm1.09$
P3 – C2	$5.70^{c}\pm1.42$	$5.75^{e}\pm1.16$	$5.85^{d}\pm1.09$	$4.60^{f}\pm1.93$	$5.65^{c}\pm1.42$	$6.10^{a}\pm0.99$

Mean values ± standard deviation of scores (*n = 20* assesors). Different superscripts letters (a-f) within indicate statistically significant differences (*p <0.05) according to Tukey's test applied after ANOVA. Samples were evaluated on 7-point Hedonic scale (1=dislike extremely and 7=like extremely).

A two-way ANOVA, with factors Factor 1 (% of juice carrot added in yoghurt) and Factor 2 (C1 and C2 culture) was performed on the sensory data and statistically significant differences (*p <0.05) was analyzed, using F_{crit} = 9.27. This revealed that the most apreciated taste is obtained by the sample P3 - C1 and P3 – C2, which display significant differences (F = 20.82 , p = 0.016) as compared to the other samples. Factor 2 does not have any influence on the taste of yoghurt samples (p = 0.29). Regarding the scores for samples' odor, the most appreciated samples were P2 – C1 and P2 – C2, which display significant differences (F = 204.6, p = 0.0006). Factor 2 does not have any influence on the odor of yoghurt samples (p = 0.215). Regarding the scores for samples' flavor, the most appreciated samples were P2 – C1 and P2 – C2, which display significant differences (F = 83767·E11, p = 0.0000). Factor 2 does not have any influence on the flavor of yoghurt samples (p = 0.215). The most apreciated texture (firmness) is obtained by sample P0 - C1 and P0 – C2, which display significant differences (F = 485.36, p = 0.00015) as compared to the other samples. Factor 2 does not have any influence on the taste of yoghurt samples (p = 0.29).

The most apreciated color is obtained by sample P0 - C1, which does not display significant differences (F = 1.740, p = 0.33) as compared to the other samples.

Factor 2 does not have any influence on the taste of yoghurt samples (p = 0.42).

The overall acceptability (figure 2) of yoghurt samples with different percentages (10%, 20%, 30%) of carrot juice and two types of bacterial cultures (C1, C2) was determined on the basis of the average of the total score obtained for different sensory attributes (taste, odor, flavor, texture or firmness, color and appearance).

Figure 2 shows that the highest overall acceptability score was obtained by yoghurt with 20% carrot juce and culture C1 (P2-C1) which obtained a main scores of 5.74 points, followed by P3-C1 (yoghurt with 30% carrot juce and culture C1) and P2-C2 (yoghurt with 20% carrot juce and culture C2) which obtained a main scores of 5,66 on a scales of 7-point Hedonic points (1 point for *dislike extremely* and 7 points for *like extremely*).

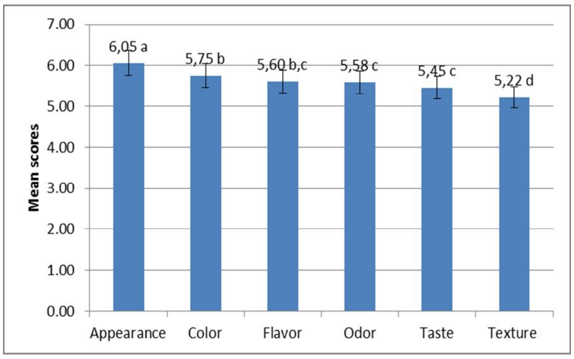


Fig. 2. Overall acceptability of yogurt samples

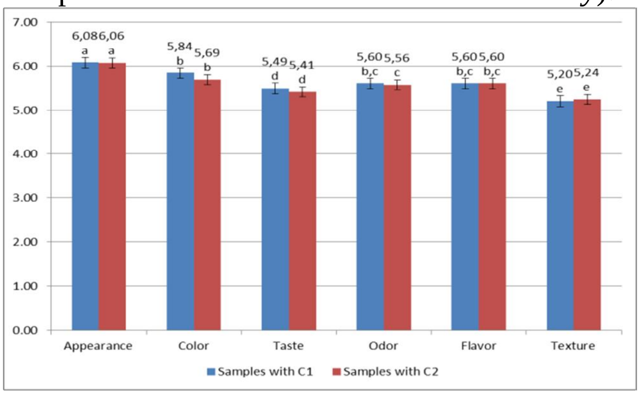


Fig. 3. The mean scores for sensorial atributes of all yogurt samples

Mean values ± standard deviation of scores (n = *8 yoghurt samples*). Different superscripts letters (a-d) within indicate statistically significant differences (*p <0.05) according to Tukey's test applied after ANOVA. Samples were evaluated on 7-point Hedonic scale (1=dislike extremely and 7=like extremely).

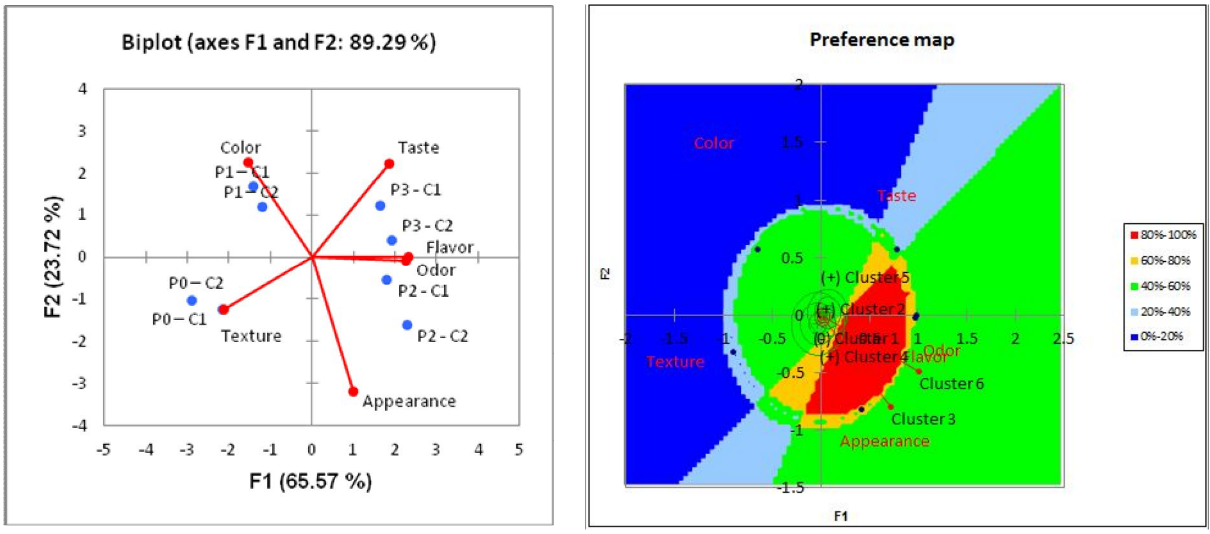
The control sample and carrot juice yoghurts (C1, C2) did not differ significantly one from another in terms of organoleptic characteristics mentioned above ($F = 0.40$, $F_{crit} = 2.01$) but the sensorial attributes (taste, odor, flavor, texture or firmness, color and appearance) have significant differences ($F = 7.91$, $F_{crit}=2.23$, p=0.02E-5). No interaction between samples and sensorial characteristics were found ($F= 1.36$, $F_{crit}=1.43$, p=0.07). Figure 3 shows that the most appreciated sensorial attributes are: appearance, followed by color, flavor and odor, taste and texture. Also, we remark that the type of culture (C1 or C2) did not influence the sensorial caracteristics of samples. The biplot for scores of yoghurt samples (mentioned in table 1) are shown in Figure 4 (a), where one can evaluate the interrelationship between the sensorial attributes (taste, odor, flavor, texture or firmness, color and appearance). It was conducted using the mean sensory scores for the sensory attributes on the correlation matrix (table 3). We can remark that the texture is negatively correlate by taste (r = -0.880), the flavor (r = -0.859) and the odor (r = -0.828), respectively. Moreover, the flavor is positively correlate by odor (r=0.994) and the taste (r=0.745). The total variance is given by the first two principal components (F1 and F2) for samples of yoghurt with different percentages (10%, 20%, 30%) of carrot juice and two types of bacterial cultures (C1,C2), respectively (Fig. 4 a.). The first principal component (F1) provides the greatest amount of information, approximately 65.57% and the second (F2) contributes by 23.72% of the data distribution. Also, the preference map for yoghurt samples is shown in Figure 4 (b).

Table 3

Correlation matrix (Pearson (n)) for sensorial atributes of yoghurt samples

Variables	Appearance	Color	Taste	Odor	Flavor	Texture
Appearance	**1**					
Color	-0.567	**1**				
Taste	-0.133	-0.230	**1**			
Odor	0.411	-0.598	**0.710**	**1**		
Flavor	0.392	-0.630	**0.745**	**0.994**	**1**	
Texture	-0.205	0.320	**-0.880**	**-0.828**	**-0.859**	**1**

Values in bold are different from 0 with a significance level α=0.05



a. b.

Fig. 4 a. Biplot b. Preference map for yoghurt samples

The main source of variance between the samples, as shown by the first principal component (F1), is given by the odor and flavor. The second principal component shows that the second most important sources of variance between the samples are apparence, taste and color. As shown by other authors [16], the changes in composition of yoghurt are strongly influenced by the addition of carrot juice in different percentages, this fact influenced the flavor, odor, apparence and color.

The external preference mapping (PREFMAP) of yoghurt samples and sensorial properties provides a multidimensional representation ([16]) of yoghurt samples with carrot juice based on their sensory profile given by taste, flavor, odor, color, texture or apparencer, obtained through Principle Component Analysis (PCA) of a data matrix with products as rows and external data as variables or columns [17]. The analysis given by the preference mapping of yoghurt samples is to fit the consumers' data in the sensory space, using a polynomial model to regress the hedonic scores obtained by samples on the coordinates of the products in the sensory space. A circular model, described by Carroll [18], was used in this representation. The preference score for each object, whose value is between 0% and 100%, is calculated from the prediction of the model used. Thus, we can remark that the most apreciated samples were P3-C2 and P2-C1, which have the position in the red area (which corespods to a rate of 80% - 100%) and the most important factors are flavor and odor.

4. Conclusions

Yoghurt is a product with multiple health benefits given by viable bacteria. The addition of carrot juice in yoghurt can improve its nutritional and sensory properties.

The mean hedonic scores for general appearance, color, taste, odor, flavor and texture (mouth-feel) and overall liking revealed that the most apreciated taste is obtained by sample P3 - C1 and P3 – C2. Regarding the scores for samples' odor, the most appreciated samples were P2 – C1 and P2 – C2. Using the scores for samples' flavor, we have remarked that the most appreciated samples were P2 – C1 and P2 – C2 and the most apreciated texture (firmness) is obtained by sample P0 - C1 and P0 – C2. Flavor and odor are important factors for the acceptability of carrot juice yoghurt and the samples P3-C2 (yoghurt with 30% carrot juice and culture C2) and P2-C1 (yoghurt with 20% carrot juice and culture C2) satisfy the tasters' acceptability requirements.

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