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Study on soymilk flavoring to increase its acceptability

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Abstract

The aim of this paper is to mask the taste of soymilk by adding a vanilla flavored beverage with the same acceptability as cow milk, in order to obtain the same flavor. The analyzed and compared samples were 1.5 wt% fat cow milk and soymilk, both products existing on the Romanian market, being flavored by 0.1, 0.2 and 0.3 wt% vanilla. Density, conductivity, pH and color of the aromatized samples as well as of the reference ones were measured. After analyzing the physical and chemical properties, as well as color and taste, we determined the optimal weight percentage of vanilla in soymilk for obtaining an equal flavor as in cow milk.

Keywords: soymilk, color, taste, smell, acceptability

1. Introduction

Soymilk constitutes a cow milk substitute for vegetarians, as it is based on a plant source. Soymilk is not technically milk, but a beverage made from soybeans, namely the remaining liquid after soybeans are being soaked and grinded. There are many people who cannot drink cow milk because of lactose allergies [1,2]. For these persons, soymilk is a healthy alternative, but not always accepted because of its taste [3 - 8].

There have been attempts to solve the flavor problem by developing soybean varieties with low lipoxygenase content, in order to decrease the fatty acid oxidation rate during the manufacturing process of soymilk, but the results are not completely satisfactory [4, 6, 8]. The problem of the undesirable flavor of soymilk involves the attempt to mask its taste by designing beverages with different flavors such as vanilla, chocolate, almond or by adding other ingredients.

To increase the acceptability rate of soymilk, vanilla was used, in percentages of 0.1, 0.2 and 0.3 wt%, and the obtained samples were compared with the cow milk flavored by vanilla in the same proportion.

2. Materials and Method

2.1. Samples and equipment

The soymilk and the cow milk – 1.5 wt% fats were purchased from a local market in Suceava, Romania. The soymilk and cow milk samples with vanilla addition, as well as the reference samples, are encoded according to *Table 1*. The vanilla we used was of organic nature.

2.2. Density, conductivity and pH determination

The density of soymilk and cow milk was calculated by using a density determination kit (XA, RADWAG) of the analytical balance (Partner XA 160).

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Table 1. Encoding of the studied milk samples

No. crt.	Milk type	Encoding
1	Cow milk – 1.5 wt% fat	LV1
2	Soymilk	LS1
3	Cow milk – 1.5 wt % fat with 0.1 wt% vanilla addition	LV2
4	Soymilk with 0.1 wt% vanilla addition	LS2
5	Cow milk – 1.5 wt% fat with 0.2 wt% vanilla addition	LV3
6	Soymilk with 0.2 wt% vanilla addition	LS3
7	Cow milk – 1.5 wt% fat with 0.3 wt% vanilla addition	LV4
8	Soymilk with 0.3 wt% vanilla addition	LS4

The conductivity of soymilk and cow milk were determined by using a conductivity meter (Accumet XL30, Fisher Scientific) and the samples' pH was measured by a calibrated digital pH meter (HQ11d pH by HACH), by the immersed glass electrode within the samples.

2.3. Color measurement

The color measurement involves the measurement of the reflection spectrum of a sample and comparison with a standard illuminant. The amount of light energy the sample reflects is manipulated and reduced to tristimulus values X, Y and Z. These values correspond to the physiological response of the three types of color receptors in the human eye. X, Y and Z values are combined into the uniform color space values: L^*, a^* and b^* [9]. The Chroma, considered a quantitative attribute of coloring, is used to determine the difference degree of the hue angle (h^*) in comparison with a grey color of the same luminosity. The description of a color using the hue angle attribute refers to how humans perceive an object's color - red, orange, green, blue, etc. The 0º or 360º angle represents the red hue, while angles of 90º, 180º and 270º represent yellow, green and blue hues [10, 11]. ΔE^* – represents the color difference magnitude between the value of the initial color and the value of the final color and gives the distance between the points representing the color, being calculated according to the equation:

$$\Delta E^* = \sqrt{\Delta a^{*2} + \Delta b^{*2} + \Delta L^{*2}} \quad (1)$$

Within the study, the HR 4000 CG-UV-NIR spectrometer (Ocean Optics Inc., Dunedin, FL) which is based on the reflection property of samples was used. In this respect, a scanning with 0.025 nm resolution has been carried out for the entire wavelength spectrum ranging from 200 up to 1100 nm. A tungsten halogen light source (UV-VIS-NIR Light Source DH-2000, Mikropack) was used. The experimental data was displayed and stored using the operating software OOI Base32 including OOIColor from Ocean Optics. The light from Light Source DH-2000 was focused to the sample through an array of optical fibres (QR400-7-UV/BX, Ocean Optics Inc., Dunedin, FL). Reflectivity was measured as against a reference standard – WS- Diffuse Reflectance Standard (Ocean Optics 2007) [12].

All the equipment used in this work belongs to the Food Safety Research Centre of the Faculty of Food Engineering, Ștefan cel Mare University of Suceava, Romania.

2.4. Sensory evaluation

A 42 member panelist judge comprising of students of the Faculty of Food Engineering in the "Ștefan cel Mare" University of Suceava, assessed the following quality attributes such as color, smell, taste and consistency using a 9 point hedonic scale.

2.5. Statistical Analysis

All the assays were conducted at least in duplicate, and the results were expressed as the mean ± standard deviation. Statistical significance was accepted at $p < 0.05$. The analysis of variance (ANOVA) of the sensory evaluation data was performed using Microsoft Excel 2010 (Microsoft Office, IRLANDA) and Principal Components Analyses (PCA) [13].

3. Results and discussions

3.1. Density, conductivity and pH values

The density value is closely linked to the total content of dry substance in milk. Excepting fat, all milk components increase the density of the milk product. Soymilk possesses a nutritionally balanced combination, which is similar to cow milk, but free of cholesterol, lactose and favorable phytochemical compounds linked to health [14, 15, 16, 17].

The value of soymilk density is much lower than that of cow milk as it can be seen in *Figure 1a*. The presence of the vanilla extract in the samples leads to an increase in both cow milk and soymilk density. Still, a more significant increase can be observed in soymilk [2, 4].

Conductivity decreases in the samples added by vanilla, as can be noticed from *Figure 1b*, so one can conclude that the decrease in conductivity is strictly related to the increase of vanilla organic nature concentration. If we weigh the cow milk samples as against the soymilk samples it can be seen that soymilk conductivity is lower than that of cow milk, due to the major differences in their origins. Soymilk is of plant origin based on complete proteins and cow milk is a rich source of nutrients as well. Cow milk contains near twice as much fat as and ten times more fatty acids than soymilk. Cow milk contains greater amounts of minerals (excepting Fe), more than three hundred fold the amount of Ca and nearly as twice as the amount of P in soymilk, but soymilk contains more Fe (tenfold) than cow milk does. Cow milk and soymilk contain nearly identical amounts of protein and water and fibre is a big plus, since dairies have none [4].

Also, as it can be seen from *Figure 1b*, the pH of cow milk is slightly acidic whereas the pH of soymilk is neutral. In cow milk and soymilk samples with vanilla addition, a decrease in the pH value can be observed. The decrease in pH is inversely proportional to the vanilla concentration. The neutral pH of soymilk makes it far more beneficial for the human body than cow milk is which has a slightly acidic pH.

3.2. Color results

Color evaluation is more than a numerical expression. It is usually an assessment of the difference in color from a known standard. Color is an important quality attribute in food industry and it influences the consumers' choice and preferences. The measurement of food color has been used as an indirect quality measure of other attributes such as flavor and pigment content [11, 18]. The aspect is one of the most important sensory attributes of fresh and processed food. The color of food is the first quality parameter appraised by consumers and it is momentous for product acceptance.

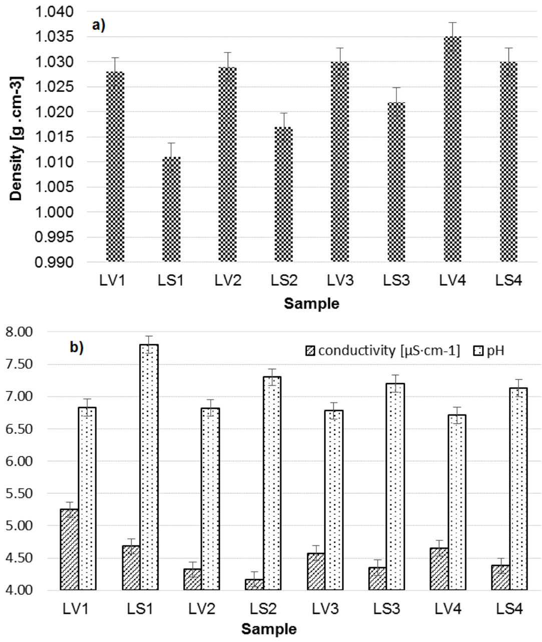

Figure 1. Representation of **(a)** density and **(b)** various conductivity and pH values in samples

Food aspect, greatly determined by color, is the first sensation that the consumer perceives and uses as a tool to accept or reject a certain type of food. Food visual aspect has a strong influence on consumer's opinion on food quality. Color can be correlated with other quality attributes such as: sensory, nutritional and visual or non-visual defects and helps control the products' quality. Color is a perceptual phenomenon which depends on the observer and on the color observing conditions. L^*, a^*, b^*, hue angle (h^*) and Chroma parameters for the samples subjected to the assay analysis were measured.

As it can be seen from *Figure 2a*, the Chroma of soymilk samples with different vanilla concentrations is more intense than the Chroma of cow milk samples with the same vanilla concentrations. The Chroma increase is directly proportional to vanilla concentration increase, so the most intense Chroma is found in the cow milk and soymilk samples with a concentration of 0.3 wt% vanilla (LV4 and LS4). *Figure 2b* shows the a^* parameter values and all values are positive which indicates that the spectrometer sensors have identified reddish hues in all milk samples. The cow milk samples with 0.3 wt% vanilla addition and soymilk samples with 0.3 wt% vanilla addition are the samples in which red hues were brighter; fact which emphasizes that vanilla pod gives milk samples a more reddish hue as compared to the control sample. The increase of the a^* parameter is directly proportional to the increase in the vanilla concentration. By comparing the cow milk and soymilk samples with the same vanilla concentrations it can be seen that soymilk samples have a higher values of the a^* parameter. Considering that the b^* parameter has positive values for yellowish colors and negative values for bluish colors, it can be observed from *Figure 2b* that all samples tend to yellowish color. The brightest yellowish colors were observed in cow milk samples with 0.3 wt% vanilla addition and in soymilk samples with 0.3 wt% vanilla addition. By comparing vanilla-added cow milk and vanilla-added soy milk, it can be noticed that the soy milk samples tend towards a brighter yellowish color. From *Figure 2c*, it can be seen that the hue angle values are between 36º and 74.08º, which demonstrates that the samples' hues are yellowish-reddish.

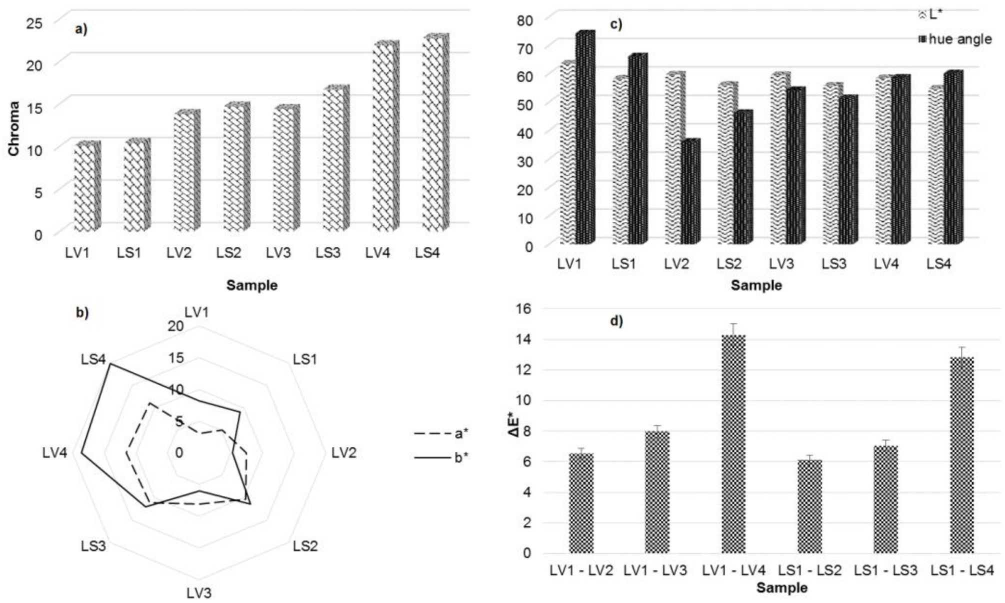

Figure 2. Representation of: **(a)** Chroma values, **(b)** *a**, *b** parameters values, **(c)** values for *L** and *hue angle* parameters and **(d)** total color difference values

Table 2. The Pearson's correlation matrices for vanilla-added milk's color, smell, taste and consistency respectively

Pearson's correlation matrices:	Color						Smell					
Variable	LV2	LV3	LV4	LS2	LS3	LS4	LV2	LV3	LV4	LS2	LS3	LS4
LV2	1						1					
LV3	0.769	1					0.805	1				
LV4	0.785	0.727	1				0.819	0.767	1			
LS2	0.782	**0.897**	0.750	1			0.830	0.816	**0.865**	1		
LS3	0.803	0.861	0.793	**0.892**	1		0.792	**0.883**	0.778	0.847	1	
LS4	**0.829**	0.692	**0.878**	0.770	**0.781**	1	**0.845**	0.782	0.852	**0.951**	**0.850**	1
Pearson's correlation matrices:	**Taste**						**Consistency**					
Variable	LV2	LV3	LV4	LS2	LS3	LS4	LV2	LV3	LV4	LS2	LS3	LS4
LV2	1						1					
LV3	0.845	1					0.000	1				
LV4	0.757	0.824	1				0.698	0.000	1			
LS2	**0.904**	0.808	0.795	1			1.000	0.000	0.698	1		
LS3	0.910	**0.897**	0.809	**0.928**	1		0.768	0.000	0.537	0.768	1	
LS4	0.873	0.868	**0.880**	0.911	**0.880**	1	**0.880**	0.000	**0.747**	**0.880**	**0.873**	1

Table 3. The variance analysis (ANOVA) of factors: color, smell, taste and consistency

Factor	Vanilla addition [%]	0.1	0.2	0.3	$F_{statistically\ calculated}$	Error Probability	$F_{critical}$	Observations
Color	Cow milk	3.547619	3.880952	4.190476	8.712898	0.000289	3.069894	significant at $p < 0.001$
	Soymilk	2.952381	3.119048	3.333333	2.705299	0.070829	3.069894	statistically insignificant at $p < 0.05$
Smell	Cow milk	3.571429	3.904762	4.309524	10.55287	5.89E-05	3.069894	significantly with $p<0.001$
	Soymilk	2.47619	2.904762	3.5	14.13828	2.97E-06	3.069894	significant at $p < 0.001$
Taste	Cow milk	4.190476	4.380952	4.547619	3.011299	0.052871	3.069894	statistically insignificant at $p < 0.05$
	Soymilk	2.904762	3.285714	3.880952	6.924324	0.001414	3.069894	significant at $p < 0.01$
Consistency	Cow milk	4.952381	5	4.97619	1.016529	0.364868	3.069894	statistically insignificant at $p < 0.05$
	Soymilk	4.952381	1.034262	0.353078	5.828676	0.003815	3.069894	significant at $p < 0.005$

Soymilk has a more reddish hue as compared to cow milk. When adding vanilla, the hue angle decreases both for soymilk and cow milk, the samples become more reddish and the hue angles are about 36º and 60.03º. Vanilla-added samples range between them, but there are not remarkable differences between vanilla-added soymilk and vanilla-added cow milk. The highest brightness (L^*) value is indicated in cow milk (LV1), *Figure 2c*.

As it can be seen from *Figure 2d*, the highest color difference (ΔE^*) is that between cow milk and the 0.3 wt% vanilla-added cow milk, followed by the difference between soymilk and the 0.3 wt% vanilla-added soymilk. The higher the vanilla concentration is, the higher the total color difference will be.

Analyzing the CIELAB color space from *Figure 3*, it can be seen that the obtained values are positioned in the first trigonometric quadrant and samples' colors are in the range red-orange-yellow. The Chroma value is 0 in the centre and it increases with distance from the centre, so the 0.3 wt% vanilla- added soy milk has a higher value for Chroma. The 0.1 wt% vanilla-added cow milk and cow milk with no vanilla addition register the lowest value for Chroma. As it can be seen from the diagram, the Chroma increase is strictly related to the vanilla addition increase. Both soymilk's color and cow milk's color are influenced by vanilla addition.

Milk samples' brightness decreases when adding vanilla, the highest decrease being noticed in cow milk, whereas milk samples' Chroma increases as the addition of vanilla is higher, so it can be mentioned that the samples' brightness is inversely proportional to samples' Chroma.

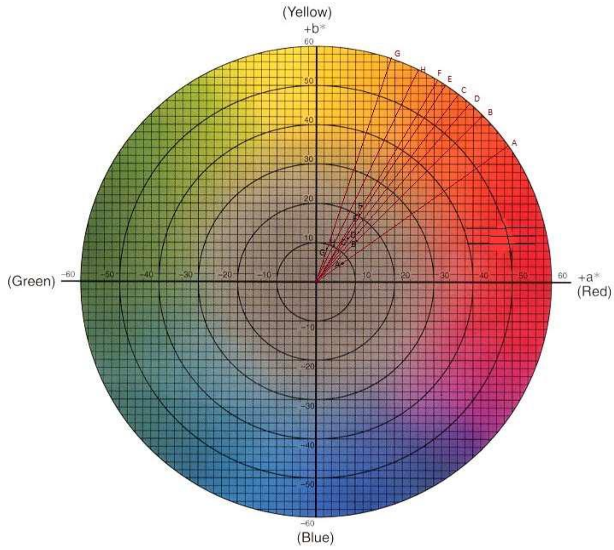

Figure 3. CIELAB color diagram for milk samples (A - LV2, B - LS2, C - LV3, D - LS3, E - LV4, F - LS4, G - LV1, H - LS1)

The samples' hue is changing when adding vanilla, the highest the amount of vanilla addition is, the smaller the hue angle is, thus the samples have a more reddish hue.

3.3. Sensory evaluation

According to *Table 2*, for color, there is a strong positive correlation, of 0.829 between 0.3 wt% vanilla-added soymilk and 0.1 wt% vanilla-added cow milk, of 0.897 between 0.1 wt% vanilla-added soymilk and 0.2 wt% vanilla-added cow milk, of 0.878 between 0.3 wt% vanilla-added soymilk and 0.3 wt% vanilla-added cow milk, of 0.892 between 0.2 wt% vanilla-added soymilk and 0.1 wt% vanilla-added soymilk and a 0.781 correlation between 0.3

wt% vanilla-added soymilk and 0.2 wt% vanilla-added soymilk.

For smell, according to *Table 2*, there is a strong positive correlation of 0.845 between 0.3 wt% vanilla-added soymilk and 0.1 wt% vanilla-added cow milk, of 0.883 between 0.2 wt% vanilla-added soymilk and 0.2 wt% vanilla-added cow milk, of 0.865 between 0.1 wt% vanilla-added soymilk and 0.3 wt% vanilla-added cow milk, of 0.951 between 0.3 wt% vanilla-added soymilk and 0.1 wt% vanilla-added soymilk and a 0.850 correlation between 0.3 wt% vanilla-added soymilk and 0.2 wt% vanilla-added soymilk.

For taste, according to *Table 2*, there is a strong correlation of 0.904 between 0.1 wt% vanilla-added soymilk and 0.1 wt% vanilla-added cow milk, of 0.897 between 0.2 wt% vanilla-added soymilk and 0.2 wt% vanilla- added cow milk, of 0.880 between 0.3 wt% vanilla-added soymilk and 0.3 wt% vanilla-added cow milk, of 0.928 between 0.2 wt% vanilla-added soymilk and 0.1 wt% vanilla-added soymilk and a 0.880 correlation between 0.3 wt% vanilla-added soymilk and 0.2 wt% vanilla-added soymilk. A strong correlation for consistency, according to *Table 2*, is noticed to be of 0.880 between 0.3 wt% vanilla-added soymilk and 0.1 wt% vanilla-added cow milk, of 0.747 between 0.3 wt% vanilla-added soymilk and 0.3 wt% vanilla-added cow milk, of 0.880 between 0.3 wt% vanilla-added soymilk and 0.1 wt% vanilla-added soymilk and a 0.873 correlation between 0.3 wt% vanilla-added soymilk and 0.2 wt% vanilla-added soymilk.By using the principal component analysis, Q1, Q2 and Q3 quartiles and the representations of Box-Plot charts, (ANOVA) analysis factors: color, smell, taste and consistency were synthesized in *Table 3*.

The score of cow milk ANOVA analysis shows that $F>F_{critical}$, which indicates that the color factor influences significantly the samples, while in the case of soymilk, color does not influence significantly the samples, $F<F_{critical}$. The smell factor influences significantly the samples, both cow milk and soymilk ones because it was demonstrated that $F>F_{critical}$.

In the case of soymilk, where it was shown that $F>F_{critical}$, taste influences significantly the samples, whereas in the case of cow milk, with $F<F_{critical}$, taste does not influence significantly the samples. Consistency influences significantly the soymilk samples because $F>F_{critical}$, but instead this factor does not influence significantly the cow milk samples, where $F<F_{critical}$.

4. Conclusions

In this paper the influence of vanilla addition on cow milk and soymilk in view to increase the acceptability of soymilk was analyzed. The results have led us to the conclusion that soymilk can be improved by adding an amount of 0.3 wt% vanilla, thus solving its characteristic problems of taste and smell regarding the equal acceptability of cow milk.

The results have also indicated that vanilla addition in milk samples lowers conductivity and pH, but increases density.

Color is a quality attribute that influences significantly consumers' choices. By adding vanilla in milk samples, color has been enhanced, making thus the soymilk samples look more attractive and appetizing.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Hajirostamloo, B.; Mahastie, P., Comparison of Soymilk and Cow Milk Nutritional Parameter, *Res J Biol Sci*. **2008**, *3*, 1324 – 1326, Available from: http://docsdrive.com/pdfs/medwelljournals/rjbsci/2008/1324-1326.pdf
2. Hajirostamloo, B., Bioactive Component in Milk and Dairy Product, *World Academy of Science, Eng Technol.* **2010**, *4*, 125 – 129, Available from: www.scholar.waset.org/1999.1/11321
3. Abdullah, M.; Saleem-ur-Rehman Zubair, H.; Saeed, H.M.; Kousar, S.; Shahid, M., Effect of Skim Milk in Soymilk Blend on the Quality of Ice Cream, *Pakistan Journal of Nutrition* **2003**, *2*(5), 305 - 311, http://www.pjbs.org/pjnonline/fin69.pdf

4. Hajirostamloo, B., Comparison of Nutritional and Chemical Parameters of Soymilk and Cow milk, *World Academy of Science, Eng Technol*. **2009**, *57*, 436 – 438, Available from: www.scholar.waset.org/1999.1/11321
5. Odu, N.N.; Egbo, N.N.; Okonko, I. O., Assessment of the Effect of Different Preservatives on the Shell-Life of Soymilk Stored at Different Temperatures, *Researcher* 2012, *4*, 62 – 69, Available from: http://www.sciencepub.net/researcher
6. Udeozor, L. O., Tigernut-Soy Milk Drink: Preparation, Proximate Composition and Sensory Qualities, *International J Food Nutrit Sci*. **2012**, *1*, 18 – 26, Available from: http://iosrjournals.org/iosr-jestft/papers/vol8-issue3/Version-1/L08318798.pdf
7. Ikya, J.K.; Gernah, D.I.; Ojobo, H.E.; Oni, O.K., Effect of Cooking Temperature on Some Quality Characteristics of Soy Milk, *Adv. J Food Sci Technol*. **2013**, *5*, 543 – 546, Available from: http://maxwellsci.com/print/ajfst/v5-543-546.pdf
8. Raja, J.; Punoo, H.A.; Masoodi, F.A., Comparative Study of Soy Paneer Prepared from Soymilk, Blends of Soymilk and Skimmed Milk, *J Food Process Technol*. **2014**, *5*: 301, Available from: http://doi:10.4172/2157-7110.1000301
9. Ocean Optics. Ocean Optics Inc 2007 Product Catalog, **2007**, Available from: http://oceanoptics.com/knowledge-support/product-catalog/
10. X-Rite 2007. A guide to Understanding Color Communication, © X-Rite, Incorporated **2007**, accessed may 2014, Available from: http://www.x_rite.com
11. Pathare, P.B.; Opara, U.L.; Al-Said, F.Al-J., Colour Measurement and Analysis in Fresh and Processed Food, *Food Bioprocess Technol*. **2013**, *6*, 36 – 60, Available from: http://doi:10.1007/S11947-012-0867-9
12. Poroch – Serițan, M.; Popescu, N. G., The relationship between nitrite concentration and colour parameters during storage of meat product - summer sausages, *Food and Environment Safety*, **2016**, *XV*, 146 – 154, Available from: http://www.fia.usv.ro/fiajournal/index.html
13. Gardiner, W.P., *Statistical analysis methods for chemists. A Software-based Approach*, Published by The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 4WF, UK, **1997**, ISBN 0-85404-549-X, 293 – 307
14. Wilkens, W. F.; Hackler, L.R., Effect of processing conditions on the composition of soymilk, *Cereal Chem J*. **1969**, *46*, 391 – 396, Available from: http://www.aaccnet.org/publications/cc/backissues/1969/documents/chem46_391.pdf
15. Omueti, O.; Ajomale, K., Chemical and sensory attributes of soy-corn milk types, *Afr J Biotechnol*. **2005**, *4*, 847 – 851, Available from: http://www.ajol.info/index.php/ajb/article/view/15195
16. Jiang, S.; Cai, W.; Xu, B., Food Quality Improvement of Soy Milk Made from Short-Time Germinated Soybeans, *Foods* **2013**, *2*, 198 - 212, Available from: http://doi:10.3390/foods2020198.
17. Santana, A.; Kurozawa, L.; Oliveira, R.; Park, K., Spray Drying of Pequi Pulp: Process Performance and Physicochemical and Nutritional Properties of the Powdered Pulp, *Braz Arch Biol Technol*. **2016**, *59*, 1 - 11, Available from: http://dx.doi.org/10.1590/1678-4324-2016150362
18. Mureșan, A., *Lecture 14. Evaluation of color*, (in Romanian), **2013**, Available from: http://www.tex.tuiasi.ro/biblioteca/carti/CURSURI/Prof.%20Dr.%20Ing.%20Augustin%20Muresan/, accessed 01-Aug-2013.