ASSESSMENT OF QUALITY OF SOME WHITE CHOCOLATE ASSORTMENTS SOLD IN ROMANIA

I.M. Pop[1*], Aida Albu[1], Gabriela Frunză[1*]

*[1]Faculty of Animal Sciences, University of Agricultural Sciences
and Veterinary Medicine of Iasi, Romania*

Abstract

The study consisted in the comparative assessment of the quality of some varieties of white chocolate sold in Romania, following their sensory, chemical (including energy value), economic and aesthetic characteristics. They were analyzed 27 samples from three varieties of white chocolate (coded A, B and C, nine samples for each producer). The sensory characteristics were analyzed by tasting, using the method of scoring scales, and the content of water, dry matter and lipids was determined by standardized classical methods; the results obtained were compared with the values declared on the label. In economic terms, the purchase price per 100 g of product was compared. Following the sensory analysis, two products were included in the category of good products (with 17.72 and 17.90 points respectively) and one in the class of very good quality (with 18.61 points). According to the information on the labels, the products studied had a variable sugar content (55-65%), fats (28-39%), protein (4.3-5.5%) and salt (0.18-0.38%); in the case of fats, the values determined by analyzes were slightly different, respectively of 28.46-38.06%. The average price (per 100 g) of the studied products varied almost to double (+ 91.2%) in the case of chocolate with the lowest sugar content and the highest fat content, but also with the highest sensory score, the lowest price being of the product richest in sugar.

Key words: white chocolate, lipids, sensory characteristics

INTRODUCTION

Cocoa paste (or liquor) is the product obtained from the fermented, dried, roasted and ground seeds of *Theobroma cacao* L. Cocoa butter (the fat pressed from cocoa paste) and sugar, it is the major ingredient of chocolate.

With regard to the chemical composition of cocoa samples (cocoa beans, cocoa powder, chocolates etc.), a rough division can be made between non-volatile and volatile components, each requiring different methods of analysis.

Besides water and primary metabolites like fats carbohydrates, proteins and dietary fibers, an important group of nonvolatile components are the polyphenols, anthocyanins, proanthocyanidins [1, 10, 14], flavonoids (quercetin and luteolin) and several phenolic acids, such as caffeic, ferulic, and coumaric acid [2].

The beneficial health effects of polyphenols are their antioxidant potential and their protective effects on the cardiovascular system [3, 5]. Another important class of non-volatile compounds in cocoa are the alkaloids, the methylxanthines being the most abundant ones.

Theobromine is the major alkaloid, followed by caffeine, and theophylline is present, but in much lower amounts. Just like the polyphenols, these methylxanthines contribute to the typical bitter taste of cocoa. Compared to coffee, cocoa contains significantly lower levels of caffeine. Theobromine levels are higher though, but its stimulating effects on the central nervous system are far less pronounced than those of caffeine [2, 13].

Amino acids and biogenic amines, like 2-phenylethylamine, dopamine and tyramine are also present. Especially during roasting,

amino acids can be converted to biogenic amines via decarboxylation.

Additional enzymatic reactions can occur, like the reaction of dopamine with acetaldehyde, which leads to the formation of salsolinol. Biogenic amines can exert important effects in the human organism. For example, 2-phenylethylamine, the "love drug", is associated with aphrodisiac effects.

Flavor is the most important criterion for chocolate quality. It is influenced by both the volatile and non-volatile fraction. During fermentation, the formation of flavor precursors like reducing sugars and free amino acids is initiated [13].

Mainly during drying and roasting of the cocoa beans, these compounds can undergo further reactions, which are important for the final flavor and aroma of the cocoa liquors and chocolates.

Reducing sugars can react with amino acids or oligopeptides via a Maillard reaction, leading to Amadori products. These can be further converted via multiple reactions into various compounds (aldehydes, ketones, furans, pyrazines, etc.) [3, 13].

Finally, conching is of utmost importance as it eliminates undesirable volatiles and reduces the moisture content, thus enhancing the flavor of the final product.

The specific cocoa aroma and final composition of cocoa liquors and chocolates are influenced by many factors, like the cocoa genotype, place of origin of the cocoa beans, season of harvesting, the practices of local farmers, and all subsequent processing steps [4, 6, 11, 13].

In the past decades, interest in "functional", healthy, and highquality food products has risen, and chocolate is one example of this. A lot of research has been carried out, mainly concerning the cardiovascular effects of (polyphenols in) chocolate.

Very recently [1] the cinnamon (*Cinnamomun burmannii*) extracts improve clearly the health-promoting properties of white chocolate.

White chocolate polyphenol content and antioxidant activity is significantly lower than for milk and dark chocolate [7]. The cinnamon extract was loaded into nanoparticles before adding it to white chocolate [8, 9].

The encapsulated cinnamon extract increased the phenolic content of white chocolate from 47.6 to 1060.6 µg /g.

The aim of this study was represented by the comparative assessment of the quality of some varieties of white chocolate sold in Romania, following their sensory, chemical (including energy value), economic and aesthetic characteristics.

MATERIALS AND METHODS

For the assesment of the quality, three types of white chocolate (produced in Germany and Romania under Swiss license/ supervision) were studied, being purchased from stores from Iasi and Vaslui.

The white chocolate taken in the study were randomly coded: A, B and C, being analyzed 27 samples (nine samples for each producer).

Sensory characteristics were analyzed by tasting, using the scoring method; the lipid content was determined by the Soxhlet method and the moisture and the dry matter by the drying method in the oven (at 105°C). In order to determine the economic characteristics, the purchase price for 100 g of product was taken into account.

The evaluation of the sensory quality of white chocolate was carried out in a sensory analysis laboratory of USAMV Iasi by the participation of a group of twenty-four students from food engineering, each receiving an individual assessment sheet (Table 1), according to standard specifications (Table 2).

Table 1. Individual assessment sheet of the sensory quality of white chocolate

Characteristics	Characteristics description	Score
Appearance	Regular shape, glossy, smooth surface, without stains and scratches; well-contoured drawings	4
	The surface is smooth, has small scratches and irregularities in design and shape	3
	The surface is matte, with small irregularities in shape and design	2
	The surface is slightly matte, showing obvious scratches, as well as irregularities in shape and design	1
	The surface is totally uneven, showing traces of melting	0
Color	Uniform and appropriate on the entire surface of the product	4
	Uneven on a certain region of the product	3
	Uneven on the entire surface of the product	2
	Stains of different shades that are not specific to the product	1
	Inappropriate product, with foreign shades, color unsuitable for the assortment	0
Smell	Well defined, pleasant, characteristic of the assortment	4
	Specific, poorly defined characteristic of the assortment	3
	Poorly pronounced, without foreign taste and smell	2
	Indefinite or too vague	1
	Unpleasant, foreign or odour is missing	0
Consistency	Strong, fine, creamy	4
	Strong, slightly creamy	3
	Soft, slightly creamy	2
	Soft, semi-rough	1
	Soft, rough	0
Taste	Well defined, fragrant, pleasant	4
	Typical of the assortment, slightly aromatic, pleasant	3
	Poorly defined, characteristic of the aroma used	2
	Indefinite or too vague	1
	Uncharacteristic, astringent, rancid, unpleasant	0

Table 2. Classification of the products in the appropriate quality class according to standards

Total average score	Provided qualifying
18.1 ÷20	Very good
15.1÷18	Good
11.1÷15	Satisfactorily
7.1÷11.0	Unsatisfactory
0÷7	Tainted

RESULTS AND DISCUSSION

The average score obtained for the sensory analysis for the three analized products (Table 3.) was 18.07 (very good products), being situated however at the inferior limit of the quality class from the standard.

Table 3. Total score obtained for the sensory analysis

Products	Total score	Qualifying
A	17.72	Good
B	18.61	Very good
C	17.90	Good
Average	18.07	Very good

The average score of sensory characteristics determined by tasting highlights differences between products, but not with high values (Figure 1.); thus, for the three analyzed products they summed the following score: 11.58 for appearance, 11.95

for color, 10.23 for smell, 11.87 for consistency and 10.78 for taste, highlighting close values for all studied characteristics.

On average was obtained: 3.86 points for appearance, 3.29 for consistency, 3.98 for color, 3.41 for smell and 3.59 for taste.
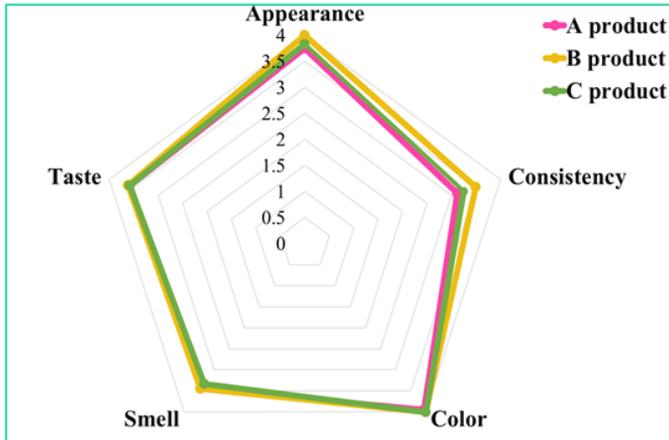

Fig. 1. The average score of sensory characteristics determined by tasting

The weighted average score obtained for the white chocolate summed the following score: 11.58 for appearance, 9.87 for consistency, 5.97 for color, 5.25 for smell and 21.57 for taste, highlighting close values

for all studied characteristics, thus slightly higher for B product (Figure 2.). On average was obtained: 3.86 for appearance, 3.29 for consistency, 1.99 for color, 1.75 for smell and 7.19 for taste.
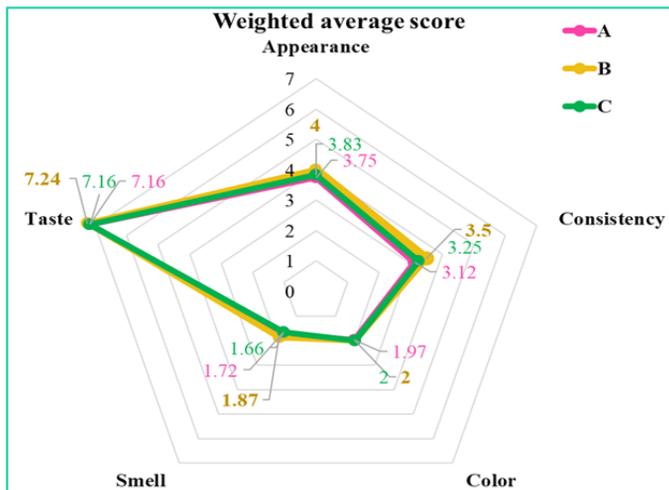

Fig. 2. Weighted average score obtained after tasting for the white chocolate

The chemical composition of white chocolate studied (values on the label, values determined in laboratory and average values)

and the energy value were presented in Table 4 and Table 5.

Table 4. Chemical composition and energy value from the label of the white chocolate

Chemical composition	Product A	Product B	Product C	Average
Carbohydrates / sugars (%)	65/65 g	55/55 g	58/58 g	59.33/59.33
Lipids / SFA (%)	28/17 g	39/25 g	33/20 g	33.33/20.66
Proteins (%)	4.3	4.7	5.5	4.83
Salt (%)	0.36	0.18	0.38	0.30
Energy kcal/100g	532	590	551	557.66

The percentage of dry matter obtained from laboratory analyzes (table 5) has a value of over 99% for all three varieties, due to the low percentage of moisture in the ingredients in the composition of chocolate, such as sugar, cocoa butter and milk powder.

After the directive EC 36/2000 sales names, definitions and characteristics of the **white chocolate** designates the product obtained from cocoa butter, milk or milk products and sugars which contains not less than 20% cocoa butter and not less than 14 % dry milk solids obtained by partly or wholly dehydrating whole milk, semi- or full-skimmed milk, cream, or from partly or wholly dehydrated cream, butter or milk fat, of which not less than 3,5 % is milk fat.

The major chemical content of these tree white chocolate products was: total carbohydrates/sugars 59.33% (between 55-65% on the label), total lipids 33.33% (28-39% on the label vs. 38.46-38.06% determined), saturated fatty acids (SFA) 20.66 % (17-25% on the label), proteins 4.83% (4.20-4.90 on the label) and salt 0.30 % (between 0.18-0.38% - on the label).

The energy value ranged from 532-590 kcal per 100 g, with an average value of 557.66 kcal per100 g; the highest energy value (590 kcal per 100 g) was observed in the product B, which also contain the highest amount of lipids.

From the point of view of **economic characteristics,** the price difference between the three varieties of white chocolate is significant, the average price of chocolate B being almost double, respectively with 91.16% higher than that of chocolate A, which has the lowest price (but also the highest sugar content, 65%).

Table 5. The chemical composition of white chocolate studied (values on the label and determined)

Content \ Product	% Dry Matter, D*	Sugars (%)		Lipids (%)				Proteins (%)		Salt (%)	
		L*	$\overline{x}$=100	D*	$\overline{x}$=100	L*	$\overline{x}$=100	L*	$\overline{x}$=100	L*	$\overline{x}$=100
A	99.63	**65**	109.56	28.46	85,26	28	84.01	4.3	89.03	0.36	119
B	99.26	**55**	92.70	38.06	114.02	39	117.01	4.7	97.31	0.18	59
C	99.16	**58**	97.75	33.63	100.74	33	99.01	5.5	113.87	0.38	125
$\overline{x}$	99.35	**59.33**	100	33.38	100	33.33	100	4.83	100	0.30	100

L - on the Label; D - Determinated in laboratory; x – Average

This price can be justified by the highest percentage of lipids content (38.06% determined/ 39% declared on the label), and the lowest content in carbohydrates/ sugar (55%), this being reflected in the superior sensory quality, chocolate B obtaining the highest score after tasting (18.61).

The price difference could be only partial justified in terms of the ingredients, and chemical content or nutritional value of the studied products, being probabily mainly determined by the marketing reasons.

Table 6. The price of white chocolate (RON/100g) compared to their average market price

Stores	A product		B product		C product	
	Price/100g	% diff.	Price/100g	% diff.	Price/100g	% diff.
Auchan	3.45	95.30	6.75	102.27	4.15	113.39
Carrefour	3.69	101.93	6.31	95.61	3.97	108.47
Kaufland	3.69	101.93	6.5	98.48	2.99	81.69
Lidl	3.69	101.93	6.93	105.00	4.09	111.75
Profi	3.69	101.93	7.06	106.97	2.89	78.96
Penny Market	3.75	103.59	6.61	100.15	3.65	99.73
Mega Image	3.97	109.67	6.58	99.70	3.79	103.55
Cora	3.80	104.97	6.38	96.67	4.27	116.67
Selgros	3.35	92.54	6.68	101.21	3.45	94.26
Metro	3.16	87.29	6.27	95.00	3.39	92.62
Average	**3.62**	100	**6.60**	100.00	**3.66**	100

The average price for all three types of white chocolate is 4.63 RON/100g.

Other characteristics. The studied white chocolate have an appropriate **packaging form,** from the point of view of integrity, all three assortments have appropriate labelling and a good mechanism to preserve quality of product.

The **quality assurance and certification** specific to product A is given by quality certification based on ISO 22000 standards. Quality assurance and certification for product B is performed based on ISO 22000 and ISO 9001 standards. The quality assurance of C chocolate is given by the existence of BRC, IFS certificates. For the production of chocolate C manufacturer also use UTZ certified cocoa and certified RSPO palm oil (Roundtable on Sustainable Palm Oil RSPO) and Fair Trade certification, for the reasons related to sustainability and transparency.

CONCLUSIONS

Following this study, it is found that of the three varieties of white chocolate analyzed, the most appreciated is B, this being due according to the tasters, its superior qualities, respectively the high degree of smoothness, well-defined flavor and fine consistency. The high degree of smoothness of B chocolate may be due to the high amount of lipid substances, its fat percentage having a higher value compared to the other two varieties analyzed.

The average price (per 100 g) of the studied products varied almost to double (+ 91.2%) in the case of chocolate with the lowest sugar content and the highest fat content, but also with the highest sensory score, the lowest price being of the product richest in sugar. The energy value ranged from 532-590 kcal per 100 g, with an average value of 557.66 kcal per100 g; the highest energy value (590 kcal per 100 g) was observed in the product which also contain the highest amount of lipids. The laboratory analysis showed only small differences in the chemical composition compared to the values indicated on the product label, but larger differences could be observed between the studied products.

REFERENCES

[1] Aji Muhammad D.R., Tuenter E., Darma Patria G., Foubert K., Pieters L., Dewettinck K., 2021: Phytochemical composition and antioxidant activity of *Cinnamomum burmannii* Blume extracts and their potential application in white chocolate, Food Chemistry, vol. 340, 127983, p. 1-6.
[2] Aprotosoaie A.C., Luca S.V., Miron, A., 2016: Flavor chemistry of cocoa and cocoa products – an overview. Comprehensive Reviews in Food Science and Food Safety, vol. 15(1), p. 73–91. https://doi.org/10.1111/1541-4337.12180.
[3] Aprotosoaie A.C., Miron A., Trifan A., Luca, S. V., Costache I.I., 2016: The cardiovascular effects of cocoa polyphenols – an overview. Diseases, 4, 39.
[4] Caligiani A., Palla L., Acquotti D., Marseglia A., Palla G., 2014: Application of 1H NMR for the characterisation of cocoa beans of different geographical origins and fermentation levels. Food Chemistry, 157, 94–99.

[5] Crozier S. J., Hurst W.J., 2014: Cocoa polyphenols and cardiovascular health. In Watson R. Ross, V. R. Preedy, & S. Zibadi (Eds.). Polyphenols in human health and disease Waltham: Academic Press. (pp. 1077–1082).

[6] Hinneh M., Semanhyia E., Walle Van De Winne A., Tzompa-Sosa D. A., Sacalone G.L.L., De Meulenaer B., Kathy Messens, Van Durme J., Ohene Afoakwa E., Dewettinck K.L, 2018: Assessing the influence of pod storage on sugar and free amino acid profiles and the implications on some Maillard reaction related flavor volatiles in Forastero cocoa beans. Food Research International, vol. 111, p. 607–620.

[7] Meng C. C., Jalil A. M. M., Ismail A., 2009: Phenolic and theobromine contents of commercial dark, milk and white chocolates on the Malaysian market. Molecules, vol. 14, p. 200–209.

[8] Muhammad D. R. A., Lemarcq V., Alderweireldt E., Vanoverberghe P., Praseptiangga D., Juvinal J. G., Dewettinck K., 2020: Antioxidant activity and quality attributes of white chocolate incorporated with Cinnamomum burmannii Blume essential oil. Journal of Food Science and Technology, vol. 57, p. 1731–1739.

[9] Muhammad D. R. A., Saputro A. D., Rottiers H., Van de Walle D., & Dewettinck K., 2018: Physicochemical properties and antioxidant activities of chocolates enriched with engineered cinnamon nanoparticles. European Food Research and Technology, vol. 244, p. 1185–1202.

[10] Paz-Yépez Carolina, Peinado Irene, Heredia Ana, Andrés Ana, 2019: Lipids digestibility and polyphenols release under in vitro digestion of dark, milk and white chocolate, Journal of Functional Foods, vol. 52, p. 196–203.

[11] Rottiers H., Tzompa SosaD. A., Van de Vyver L., Hinneh M., Everaert H., De Wever, J.,... Dewettinck K., 2018: Discrimination of cocoa liquors based on their odor fingerprint: a fast GC electronic nose suitability study. Food Analytical Methods, 12(2), 475–488.

[12] Tuenter Emmy, Delbaere Claudia, Ann De Winne, Bijttebier S., Deborah Custers, K. Foubert, Van Durme J., Messens Kathy, Dewettinck K., Pieter L., 2020: Non-volatile and volatile composition of West African bulk and Ecuadorian fine-flavor cocoa liquor and chocolate. Food Research International vol. 130, 108943, p. 1-11.

[13] Tuenter, E., Foubert, K., & Pieters, L., 2018: Mood components in cocoa and chocolate: The mood pyramid. Planta Medica, 84(12/13), 839–844.

[14] Wollgast, J., Anklam, E., 2000: Review on polyphenols in Theobroma cacao: Changes in composition during the manufacture of chocolate and methodology for identification and quantification. Food Research International, 33, 423–447.