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Preliminary Communication

FAT TYPES AND THEIR FUNCTIONAL EFFECT ON THE SENSORY QUALITY OF MUFFINS

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Abstract

Effects of major fat types such as butter, margarine, and sunflower oil on the physical and sensory characteristics of muffins were examined in this study. The sensory quality and overall acceptability of muffins were carried out on a 10-point scale. Functional and sensory properties of muffins prepared by supplementing the same proportions of different fat types, wheat flour (WF) sugar were studied. Three formulations of muffins were prepared (a) control with sunflower, (b) with margarine, and (c) with butter. The samples were rated based on the criteria: 10 being highly acceptable and 0 being completely unacceptable concerning different characteristics.
Significant effects ($P<0.001$) of fat types on the crust shape, taste, and oiliness of the muffins were shown using the SPSS test of ANOVA. Moreover, the Spearman correlation test ($P<0.001$) showed a positive correlation between taste and sample number toward butter (0.48) and negative relation between oiliness and butter sample (-0.35) and crust color with cracking (-0.33). It is important to understand the molecular basis of the different fat types and their impact on technological changes in muffins. In conclusion, the functionality of fat types had a radical contribution to muffins affecting the quality to different extents.

Keywords: fat type, functional properties, fat crystallization, consumer's acceptability

1. Introduction

The molecular structure of fats and oils and their crystalline networks are essential for baked products and the shelf life of the final product. In addition to their nutritional profiles, the selection of fats and oils should be based on their specific performance within the end product (Wainwright,1999; Ghotra et al.,2002; Lai and Lin, 2006). The complex microstructure of cookies characterized by the presence of holes and heterogeneity impacts the mechanics of breakdown which can develop defects during the cracking (Hedjazi et al., 2011). Baltsavias et al. (1999) reported that the fat causes a reduction in the breaking stress of the products as it is responsible for decreasing the air size playing a remarkable role in the breaking effort of the biscuits and the physical properties in general. Also, fat type has an important role in tenderness, richness, and shortening, and improves flavor and mouthfeel distribution (Hađnadev et al., 2011). The third most important ingredient used in production quantitatively is fats and oils which influence overall texture regarding sensory quality perspective. Also, the fat amount added has an intense impact on the final quality. As discovered in numerous earlier studies, decreasing the fat content or substituting fat with different components has a major impact on the sensorial characteristics as mentioned in earlier investigations (Rodriguez-Garcia et al. 2012; Zoulias et al. 2002). From both functional and nutritional perspective fats and oils are technically of huge importance in the quality of food systems. Ghotra et al. (2002) reported that the most frequently used fats in recipes are butter, shortenings, and margarine; however, they often contain elevated amounts of saturated fatty acids and possibly trans-fatty acids. Also, butter is considered “natural” by consumers due to its desirable flavor (Sulejmani et al., 2023).

Food companies are making concerted efforts to accelerate innovations in the use of healthier fats and reduce overall fat content, primarily in response to known health-related issues. But there could be some technical problems and changes in the rheological properties linked to elasticity, extensibility, and spreadability. Also, a reduction of the specific odors and flavors given by the fats can occur (Ashwath Kumar and Sudha, 2021; Savadogo, 2021; Yazar and Rosell, 2022).

The impact of fat level and types has been previously investigated by Manohar and Rao (1999) who found significantly greater thickness when using hydrogenated fats or oils. Also, cookies containing liquid oil had a comparatively harder texture compared to the bakery and hydrogenated fat (Jacob and Leelavathi, 2007). Considering fat functionality, an essential factor is the ratio of the liquid phase to the solid phase often expressed as the Solid Fat Index (SFI) in the dough. This ratio determines the functional quality and textural performance of products. Normally, bakery fats (margarine and butter) contain approximately 80 % fat, whereas sunflower oil consists of 100 % fat. Sunflower oil is a popular oil among the most used vegetable oils for edible applications due to its higher content of unsaturated fatty acids relative to saturated ones.

In this investigation, the knowledge of the sensory descriptors that mostly influence the consumer's acceptability and the properties of those related results is of great interest. It is reported the effect of fat in defining the sensory and especially textural characteristics of muffins. Three types of fat, namely sunflower oil, margarine, and butter, were used for semi-sweet muffin production. The reason for choosing three types of fat is to provide a better alternative for the best sensory attributes used in bakery products.

2. Material and methods

All-purpose flour, granulated sucrose, sunflower oil (C1), vegetable margarine (C2), butter (C3), and baking powder (sodium bicarbonate and ammonium bicarbonate, 2:1) were purchased from local supermarkets (Table 1). The ingredients were mixed for 5 min in a dough mixer and after a resting period of 30 min, the dough was then manually placed in the baking container. Each dough batch was allowed to obtain muffins formed into discs with a diameter of 5 cm. Each dough formulation was prepared twice on different days and baked under baking conditions of 150°C/50 min. The materials used for making muffins are all-purpose flour, butter, sugar, egg, black cumin, and baking powder were procured from the local market.

Table 1: Total amount of ingredients (in grams) in samples of muffins produced with sunflower oil (C1), margarine (C2) and butter (C3).

Ingredients	C1	C2	C3
All-purpose flour	80	80	80
Milk	75	75	75
Sugar	100	100	100
Egg	1	1	1
Fat	80	80	80
Black cumin	5	5	5
Baking powder	1\4	1\4	1\4

The sensory evaluation of the muffins took place after the cakes were baked and allowed to cool. The sensory evaluation of fresh muffins was determined by trained panelists selected from the Department of food technology at the University of Tetova. These panelists were instructed to assign numerical scores to each sample on a 1 to 10-point hedonic scale, evaluating characteristic color, flavor, texture, and overall acceptability of muffins. The scale is absent, hardly observed, very slightly observed, slightly observed, observed, moderately observed, very moderately, high, very strong, and extreme.

2.1. Consumer's acceptability test: The sensory acceptability of muffins was evaluated by a panel of 156 untrained judges, comprising 16 males, and 140 females, with ages ranging from 20 to 60 years old. Each judge evaluated all the muffins twice and the overall acceptability of muffins was calculated as the average of their assessments across various sensory parameters. A ten-point hedonic scale (from 1 = dislike extremely to 10 = like extremely) was used by the panelists to consumer's sensory evaluation.

2.2. Statistical analysis: The data underwent an Analysis of Variance (ANOVA) using (SPSS Statistics 13.0, Armonk, NY, USA) to assess the significant differences ($P<0.05$) within samples baked under the same conditions. Correlation analysis (Pearson test) was performed to understand the statistically significant differences and explore the relationship between fat type and each sensory descriptor.

3. Results and discussion

Table 2 presents the sensory analysis results for the muffin samples prepared with different fat types. Figure 1 illustrates that the sensory profiles of muffins prepared with solid fats (C2 and C3) significantly differed from those prepared with oil (C1). The taste of butter and milk emerged as the predominant sensory descriptors characterizing C3 muffins and setting them from the others.

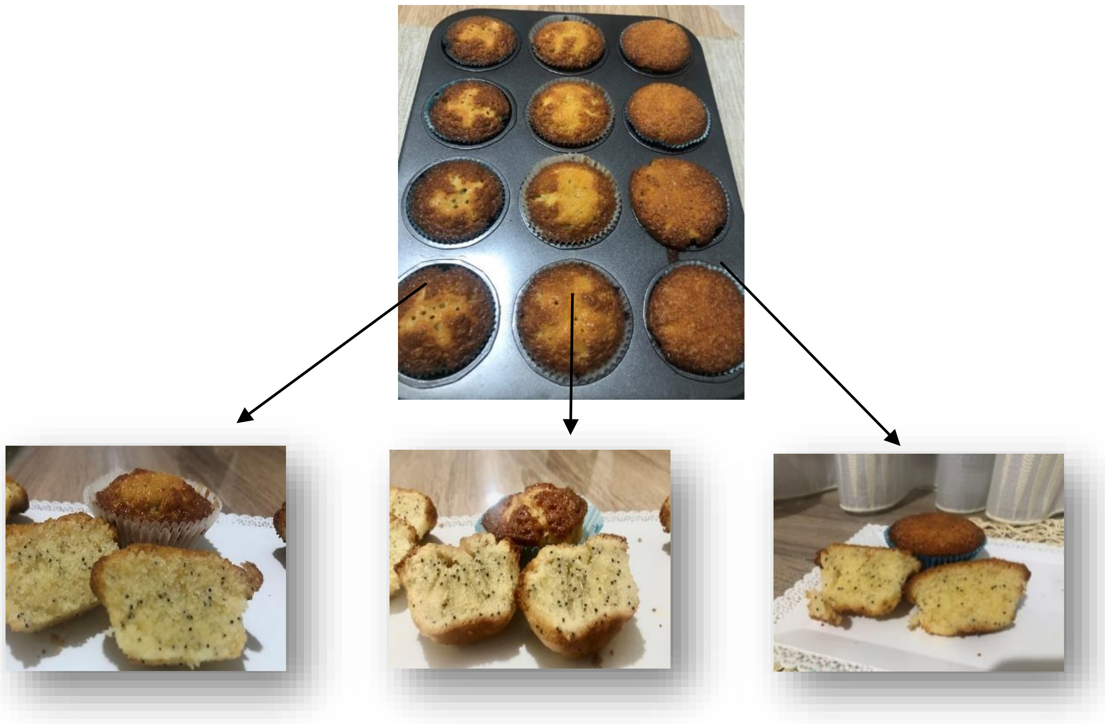

Figure 1. Appearance of the muffins produced with sunflower oil (C1), margarine (C2) and butter (C3).

In addition, muffins prepared with margarine resulted to have a sweeter taste than C1 ones, even if this feature was not statistically significant ($P > 0,05$). The advantage of sensory methods over other methods of texture measurement is for enabling an immediate analysis, the complexity of perception, integration, and interpretation of a large number of single textural sensations at the same time. From a sensory point of view, the hardness of solid food is defined as the force required to compress a substance when placed between molar teeth (Szczesniak, 2002).

Table 2. General sensory characterization of muffins

Sensory characteristics	***C1***	***C2***	***C3***
Form regularity	7.84^{b}	6.32^{a}	7.48^{b}
Crust cracks	2.82^{a}	3.63^{a}	3.09^{a}
Color	7.76^{a}	7.98^{ab}	8.26^{b}
Porosity	6.56^{ab}	7.19^{b}	6.13^{a}
Taste	4.59^{a}	6.30^{b}	7.21^{c}
Softness	6.82^{a}	7.71^{b}	7.19^{ab}
Juiciness	7.05^{b}	6.23^{b}	5.75^{b}
Sweetness	6.44^{a}	6.55^{a}	6.09^{a}

^{a,b,c} Different superscript lowercase letters in the same row indicate significant differences at $P < 0.05$ within each muffin formulation (sunflower oil, C1; margarine, C2; and butter, C3).

In the study, a Chi-square test was conducted to determine whether consumers (n = 156) had a significant rank-ordered perception of the manufactured muffin samples (Figure 2 The analysis results revealed significant rank-ordered perceptions for all samples in terms of porousness, taste, and color (P < 0.05). It can be concluded that consumers cannot detect any differences in softness or hardness between the samples. Post hoc tests (ANOVA) results showed that there was a statistical difference between biscuits made of butter and sunflower oil or margarine. The actual force difference between the biscuits was small. The highest and the lowest values of softness or hardness differ by about 0,89 points and may not be sufficient for the panelists to detect.

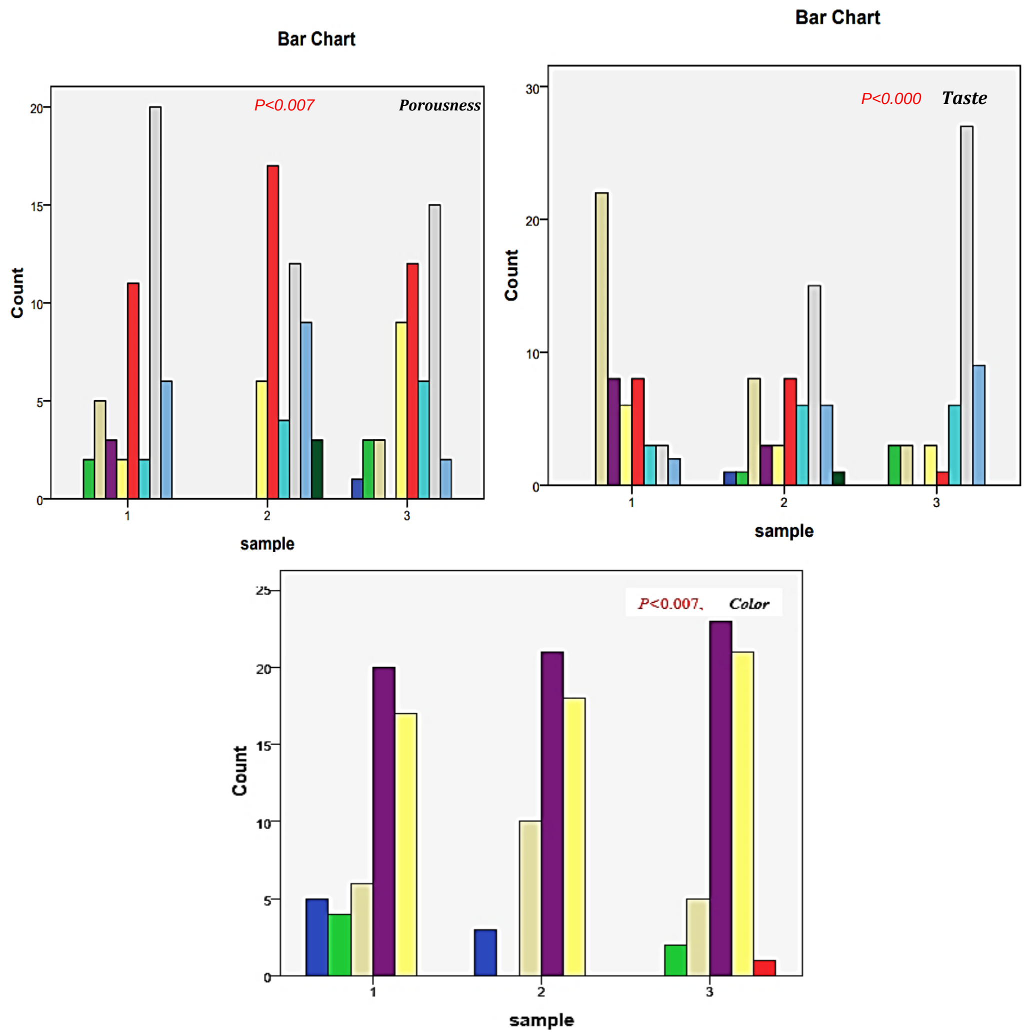

Figure 2. Chi –Square test of significant distribution of muffins samples with different fat types (1-sunflower oil, 2- margarine, 3-butter)

The correlation test values of the muffins under study are presented here. These values were derived from three different batches, each containing a total of 52 samples. The results obtained showed that muffins prepared with sunflower oil and butter exhibited lower softness or greater hardness and were significantly different (P<0.05) from the muffins made from margarine.

Similarly, a study by Mamat and Hill (2014) reported that biscuits made with vegetable oil fraction and butter had the highest breaking force. Also, O'Brien et al. (2003) found that biscuits produced using lower free fat content (high solid fat) exhibited higher breaking strengths. and distinct flavor notes. In general, products containing milk fat tend to receive higher sensory scores, although products with vegetable fat are still acceptable in terms of texture and sensory attributes.is acceptable texturally and sensory

Table 3. Correlations of general sensory characterization of muffins

		Sample	Form	Cracks	Color	Porosity	Taste
Sample	Pearson Correlation	1	-.082	.043	$.192^{*}$	-.093	$.470^{**}$
	Sig. (2-tailed)		.306	.598	.017	.252	.000
	N		156	156	156	153	156
Form	Pearson Correlation		1	-.039	-.074	.007	$-.325^{**}$
	Sig. (2-tailed)			.630	.359	.929	.000

	N	156	156	153	156
Cracks	Pearson Correlation	1	-.327**	.283**	.202*
	Sig. (2-tailed)		.000	.000	.011
	N		156	153	156
Color	Pearson Correlation		1	-.056	.090
	Sig. (2-tailed)			.490	.264
	N			153	156
Porosity	Pearson Correlation			1	-.008
	Sig. (2-tailed)				.918
	N				153
Taste	Pearson Correlation				1
	Sig. (2-tailed)				
	N				

		Softness	Juiciness	Sweetness
Sample	Pearson Correlation	.088	-.350**	-.110
	Sig. (2-tailed)	.274	.000	.172
	N	156	156	156
Crust	Pearson Correlation	-.055	-.064	-.109
	Sig. (2-tailed)	.495	.424	.177
	N	156	156	156
Cracks	Pearson Correlation	.217**	.220**	-.022
	Sig. (2-tailed)	.006	.006	.782
	N	156	156	156
Color	Pearson Correlation	.127	-.222**	.017
	Sig. (2-tailed)	.114	.005	.833
	N	156	156	156
Porosity	Pearson Correlation	.199*	.332**	.257**
	Sig. (2-tailed)	.014	.000	.001
	N	153	153	153
Taste	Pearson Correlation	.343**	-.178*	.247**
	Sig. (2-tailed)	.000	.027	.002
	N	156	156	156
Softness	Pearson Correlation	1	.069	-.044
	Sig. (2-tailed)		.391	.587
	N		156	156
Juiciness	Pearson Correlation		1	.138
	Sig. (2-tailed)			.086
	N			156
Sweetness	Pearson Correlation			1
	Sig. (2-tailed)			
	N			

**P < 0.05, ** P<0.001.*

4. Conclusions

Fat plays various function in providing desirable textural properties and are a significant ingredient in baking products, particularly muffins. Sensory analysis showed that the type of fat significantly influenced the muffins' shape, porosities, and taste. Muffins made with butter received higher scores for taste and color, but this was not observed in terms of shape regularity. Correlation analysis indicated a significant positive association between the taste and tenderness of the muffins, while color and crust cracks had a negative correlation. It is important to be able to understand the critical properties of fat types within muffins so that a reliable selection about the type and quantity of fat type can be made. Fats appear to be important in the initial stages of muffin manufacture and despite using very different types of fat, the muffin's sweetness and juiciness were not very different. Therefore, it can be concluded that the most important contributor to the overall acceptability of muffins is fats. So, the results demonstrated different fats resulted in muffins with characterized typical sensory profiles. The sensory approach applied, allowed us to relate chemical and sensory data and identify the main features on which consumers focus their preferences. Particularly, the external preference has been able to relate the consumers' scores to the sensory attributes of the muffin samples. The use of butter remains the best choice for muffin production.

References

[1]. Ashwath Kumar, K. and Sudha, M.L. 2021. Effect of fat and sugar replacement on rheological, textural and nutritional characteristics of multigrain cookies. Journal of Food Science and Technology, 58, 2630–2640.

[2]. Baltsavias A, Jurgens A, and Van Vliet T. 1999. Fracture properties of short-dough biscuits: effect of composition. Journal of Cereal Science, 29(3),235–244.

[3]. Ghotra, B.S., Dyal, S.D. and Narine, S.S. 2002. Lipid shortenings: a review. Food Research International, 35, 1015–1048.

[4]. Hađnadev, M., Dokic, L., Hađnadev, T. D., Pajin, B. and Krstonosic, V. 2011. The impact of maltodextrin-based fat mimetics on rheological and textural characteristics of edible vegetable fat. Journal of Texture Studies, 42, 404–411.

[5]. Hedjazi L, Guessasma S, Della Valle G, and Benseddiq N. 2011. How cracks propagate in a vitreous dense biopolymer material. Engineering Fracture Mechanics 78(6):1328–1340.

[6]. Jacob J, Leelavathi K. 2007. Effect of fat-type on cookie dough and cookie quality. Journal of Food Engineering 79:299–305.

[7]. Lai HM, and Lin TC. 2006. Bakery products: science and technology. In: Hui YH, Corke HH, De Leyn HI, Nip WK, Cross N (eds) Bakery products: science and technology. Blackwell Publishing, Hoboken, pp 3–6.

[8]. Mamat H, and Hill SE. 2014. Effect of fat types on the structural and textural properties of dough and semi-sweet biscuit. Journal of Food Science and Technology, 51(9),1998-2005.

[9]. Manohar S, and Rao H. 1999. Effect of mixing method on the rheological characteristics of biscuit dough and the quality of the biscuits. European Food Research Technology, 210,43–48.

[10]. Merlino M., Arena E., Cincotta F., Condurso C., Brighina S., Grasso A., Fallico B. and Verzera, A. 2022, Fat type and baking conditions for cookies recipe: a sensomic approach. Internatioanl Journal of Food Science and Technology, 57, 5943-5953.

[11]. O'Brien CM, Chapman D, Neville DP, Keogh MK, and Arendt EK. 2003. Effect of varying the microencapsulation process on the functionality of hydrogenated vegetable fat in short dough biscuits. Food Research International, 36,215–221.

[12]. Rodriguez-Garcia J, Laguna L, Puig A, Salvador A, and Hernando I. 2012. Effect of fat replacement by inulin on textural and structural properties of short dough biscuits. Journal of Food Science, 77(2),C189–C197.

[13]. Savadogo A. 2021. Effect of three types of oils and their level of incorporation on sensory quality of sorghum cookies. Food Research, 5, 190–202.

[14]. Sulejmani E., Ahmeti B. and Musliu, Z.H. 2023. Profile of fatty acid and pesticide residues of cream and yoghurt butter during storage. Mljekarstvo, 73 (1), 12-21.

[15]. Sulejmani E., Beqiri L. and Popeski-Dimovski, R. 2021. Effect of vegetable fat on the texture, colour and sensory properties of Macedonian white brined cheese. Mljekarstvo, 71 (1), 25-34.

[16]. Szczesniak AS. 2002. Texture is sensory property. Food Quality & Preference 13(4),215-225.

[17]. Wainwright B. 1999. Oils and fats for the baking industry. Cereal Foods World 44:SR16–SR19

[18]. Yazar G. and Rosell, C.M. 2022. Fat replacers in baked products: their impact on rheological properties and final product quality. Critical Reviews in Food Science and Nutrition, 1–24.

[19]. Zoulias EI., and Oreopoulou V, Tzia C. 2002. Textural properties of lowfat cookies containing carbohydrate- or protein-based fat replacers. Journal of Food Engineering, 55(4),337–342.