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Impact of Fats on Rusk Quality Deterioration

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Abstract

This paper investigates the impact of pan release grease and its interactions with fats incorporated in the dough on rusk quality. To obtain systems sensitive to lipid changes in rusk, experiments were designed varying compound fat (constituent of dough) characteristics (hydrogenated sunflower oil or lard) and pan release presence. Changes in rusk lipid component were traced through sensory, texture, color and microbiological characteristics, peroxides and acidity over 360 days of storing period. Fat type in rusk dough significantly affects its texture, color and sensor characteristics. The influence of multiple pan greasing is noticeable in samples stored during longer periods (180 and 360 days). After these periods of storage rusk samples with both types of fat used, without multiple pan greasing, had shown less deterioration of taste descriptors, peroxides and acidity contrary to rusk samples with multiple subsequent greasing. Technological operation of greasing has influenced the increase of the peroxides, statistically insignificantly after 0 and 60 days of storage, while statistically significantly after 180 and 360 days, thus emphasizing the negative contribution of pan release grease impact.

Keywords: rusk,compound fat, pan release, shelf-life

1. Introduction

Generally bakery products are appetizing as long as they are fresh. Bread quality changes with time. This is true for all types of bread and time after baking leads to loss in quality thus become unfit to be sold or stored for a longer period (PYLER & GORTON [1]). Among variety of bakery products, rusk is unique. It is characterized with long shelf-life, also recognized to be beneficial in many diets. Rusk, as a subgroup of bakery products, often has quite specific processing conditions and requires closely specified ingredients. The close relationship between ingredients and processing contributes to the wide diversity of rusk products. A change of one aspect of the ingredient-formula-process triumvirate may well be balanced by changes in one or both of the other aspects. There is a great variety of rusk ingredients, but essential are fat, milk solid and sugar.

Following Knowledge based systems (CAUVAN & YOUNG [2]) for bread type goods, rusk shelf-life is closely related to the composition of raw materials, above all the type and quality of used fats, either type of shortening or compound fat, in dough formula or type of pan grease release (FILIPOVIĆ & al. [3]; PAJIN & al. [4]; CHIN & al. [5]). MAIRE & al. [6] proved that formulas containing the highest amount of polyunsaturated fatty acids showed the highest oxidation potential in the case of alveolar baked products in case endogenous antioxidants were absent.

In more recent times, an understanding of the chemistry of fats has led to the development of the compound fats that are commonly used in the processing of almost all baked products today (CHIN & al. [5]). The key role of fats in rusk baking processes requires a more detailed explanation of the composition of bakery fats. They are in fact mixture of solid fat and liquid oil of different types. Today vegetable fat sources dominate the blends, whereas in the past animal sources, particularly lard, were commonly used as main part of the composite fat (PYLER & GORTON [1]).

The variation in fat chemistry, particularly saturated fatty acids content, has a profound effect on its physical form. In particular, the variations account for the difference in temperature at which pure oil will make the transition to a solid (CAUVAN & YOUNG [2]).

Oils and fats along with milk solids and sugar are added to modify the mouth-feel of rusk as a final product. In bread making process oils and fats are also recognized as beneficial in: stabilization of gas bubbles incorporated into the dough, improvement of the gas-retention properties, stabilization of gas bubbles incorporated into the dough and inhibition of gas-bubble coalescence (PYLER&GORTON [1]; STAUFFER [7]).

Sucrose and milk powders confer sweetness, color andflavor to rusk, but also has a key function in structure formation (CAUVAN & YOUNG [2]).

This paper covers both sensor and chemical characteristics of rusk with the aim to highlight contribution of pan release grease and its interaction with fat type incorporated into the rusk dough on rusk shelf-life over 360 day of storing period.

2. Materials and Methods

Material

White wheat flour (wet gluten 25%, protein content 12.0% d.m., ash content 0.47% d.m.) was purchased from local miller. Defatted milk powder, salt, sugar and baker's yeast, were of commercial grade, supplied by the courtesy of local bakery. For this experiment, two types of compound fats designed in experimental phase (supplied by the courtesy of local oil factory) were practiced in the quantity of 5% on flour basis. Hydrogenated sunflower oil, without transfatty acids, was the main constituent of Fat 1, and lard was the main constituent of Fat 2. Commercial pan release grease Carlo, was supplied by Zeelandia Serbia.

Methods

Rusk preparation

Baking experiments were designed to characterize the extent of fat deterioration influenced by fat characteristics and applied pan release grease either in crust, crumb or whole piece of rusk over a period of 360 days.

Both types of rusk were prepared in the laboratory on pilot plant according to following formula: defatted milk powder, salt, sugar and baker's yeast, in the quantity of 2.0%, 5.0%, 1.5% and 2.5% on flour basis, respectively. Water was added according to farinograph absorption (round 59% flour basis). Fat was added in the quantity of 5% on flour basis. Pan bread was prepared according to standard baking procedure AACC [8]. Prepared dough, weight 450g, was placed in Teflon plated lidded pans. For following the interaction of pan release grease and dough constituents (primarily fats) on rusk quality, dough samples were placed either in non-greased pans or in pans greased with commercial pan release after 10 subsequent baking, without cleaning in-between, (for tracing the influence of left over pan grease). 24h after baking loaf was cut in slices 0.9 cm thick. For rusk preparing, bread slices were placed on non-greased tin and baked in the oven at 200°⌉, exactly 10 min. After cooling at ambient temperature, 2 slices were packed in OPP/OPP Duplex foil, as described by FILIPOVIC & al. [9]. Experiments were run under the same conditions in ten replicates.

Packing and storing conditions

During the whole storing period, slices of rusk packed in above mention packing material were stored 12 month at room temperature (T=20°±2°⌉), maintained by air condition and controlled by digital thermometer and displayed to day light. Tests were performed in samples before packing (0 day) and after storing period of 60, 180 and 360 days. Sampling was according national OFFICIAL METHODS [10].

Colour

The colour was measured using a Chroma meter (CR-400, Konica, Minolta, Tokyo, Japan) tri-stimulus colorimeter on powdered sample placed in a small bowl with a cover in order to provide an uniform flat surface of following samples: whole rusk slice, crust (thin crust with adhering 0.5 cm) and crumb (central part of rusk slice). The L* a* b* colour scale was used as colourindex. The results were expressed in terms of*- brightness (from 0 (black) to 100 (white)), a*: greenness/redness (from -a* (green) to +a* (red)), b*: blueness/yellowness (from -b* (blue) to +b* (yellow)) as per CIELab system. The measurements were observed under constant lighting conditions, at 28ºC, using a white control (L*=98.76, a*=-0.04, b*=2.01) (BABUSKIN& al. [11]).

Texture evaluation

Textural properties of rusk slices were measured with Texture Analyzer TA.HD plus (Stable Micro System, U.K.) equipped with a 30-kg load cell. Hardness and fracturability of rusk slices were measured using a 36 mm cylinder probe (P/36R) (instrument settings were as follows, mode: measure force in compression, pre-test speed: 1.0 mm sec−1; test-speed: 3 mm sec−1; post-test speed: 10 mm sec−1; strain: 75%; trigger force: 5 g). The maximum force correlates to the hardness of the sample. Fracturabilityis calculated from the negative areas of the plots. The tests were performed on 10 replicates per batch.

Peroxides

Peroxides as indicator of lipid deterioration were determined in accordance with AOAC OFFICIAL METHODS [12].

Acidity

Acidity was measured in 67% ethanol extract according national OFFICIAL METHODS [10].

Microbiological analysis

Determination of the *Enterobacteriaceae*, Yeasts and mouldsand*Bacillus cereus* was done by the SRPS EN ISO 21528-2 [13]; SRPS EN ISO 21527-1 [14]; and SRPS EN ISO 7932 [15] respectively.

Sensory quality

Sensory analysis was conducted according to SRPS ISO 4121 [16], by panel of six trained evaluators. Evaluators identified descriptors, and scored taste using 6 point scale (0 – not detected, 5 – strong).

Score analysis

Score analysis uses min-max normalization of analyzed responses and transfer them from their unit system in new dimensionless system which allows further mathematical calculation of different types of responses (JAYALAKSHMI & SANTHAKUMARAN [17]).

$$S_{1i} = \frac{(Water\ Content_i - Water\ Content_{min})}{(Water\ Content_{max} - Water\ Content_{min})} \quad (1)$$

$$S_{2i} = 1 - \frac{(Hardness_i - Hardness_{min})}{(Hardness_{max} - Hardness_{min})} \quad (2)$$

$$S_{3i} = 1 - \frac{(Fracturability_i - Fracturability_{min})}{(Fracturability_{max} - Fracturability_{min})} \quad (3)$$

$$S_{4i} = 1 - \frac{(Peroxides_i - Peroxides_{min})}{(Peroxides_{max} - Peroxides_{min})} \quad (4)$$

$$S_{5i} = 1 - \frac{(Acidity_i - Acidity_{min})}{(Acidity_{max} - Acidity_{min})} \quad (5)$$

$$S_{6i} = 1 \quad \frac{(Sensory\ characteristics_i - Sensory\ characteristics_{min})}{(Sensory\ characteristics_{max} - Sensory\ characteristics_{min})} \quad (6)$$

$$S_i = \frac{(S_{1i}+S_{2i}+S_{3i}+S_{4i}+S_{5i}+S_{6i})}{6} \quad (7)$$

Statistical analysis

Statistical analysis of experimental data was performed using MICROSOFT EXCEL [18] and STATISTICA [19].

3. Results and Conclusions

Average values and their standard deviation of the water content of the tested samples with fat 1 and fat 2 with multiple pan greasing during tested period are presented in table 1. Values ranged from 4.62±0.56 to 5.14±0.33, pointing that applied OPP/OPP duplex foil, mostly practiced by rusk producers, is slightly permeable for water vapor and gases. Pertinent data are consistent with results reported by FILIPOVIĆ & al. [9].

Table 1. Water content of tested rusk samples with multiple greasing during storage

Sample	Days of storage			
	0	60	180	360
Rusk sample with fat 1	5.14±0.13[a]	5.05±0.13[ab]	4.98±0.13[ac]	4.75±0.19[cd]
Rusk sample with fat 2	5.01±0.09[ac]	5.01±0.06[a]	4.82±0.22[bce]	4.62±0.16[d]

[abcde] Different letters in the superscript in the table indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

It can be seen that in technological operation of dough rusk preparation, type of the fat used has statistically insignificant influence on rusk water content, but rusk samples produced with fat 1 had slightly higher water contents through all storage periods.

Due to wrapping foil permeability, duration of storage statistically significantly decreased rusk water content with both fat used in production process and these data are consistent with packaging material characteristics experienced by FILIPOVIĆ & al. [9].

Table 2. Colour parameters of rusk samples produced with different fat types

	Rusk sample with fat 1	Rusk sample with fat 2
L^* - brightness	71,31±0,59[a]	66,65±1,30[b]
a^* - share of red colour	5,54±0,23[a]	7,85±0,24[b]
b^*- share of yellow colour	25,14±0,43[a]	27,85±0,32[b]
C - the differences in colouration	25,75±0,47[a]	28,93±0,32[b]
h - difference in tone	77,58±0,31[a]	74,26±0,48[b]

[abcde]Different letters in the superscript in the rows indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

In this investigation the contribution of fat characteristics is tested through changes in color, texture and sensor attributes of rusk. In the table 2. average values and their standard deviations of color parameters of rusk samples produced with two different fats, prior to wrapping, are presented. Color formation mostly happens at surface of bread slices in the second baking stage. It can be seen that in the same baking conditions fat type statistically significantly affects all color characteristics of rusk. Brightness and difference in tone values were statistically significantly lower in rusk samples with fat 2, while values of share of red color, share of yellow color and the differences in coloration were statistically significantly lower in rusk samples with fat 1 probably due to hydrogenation process. These results point at more favorablecolourattributes of rusk samples produced with natural fats, like fat 2, which, due to processing, has a variety of other compounds (STAUFFER [7]). According to MUNDT & WEDZICHA [20] it also may be due to lower rusk water content. The textural characteristics of rusk have an essential role in determining the final acceptance by consumers. Texture characteristics were expressed by values of hardness and fracturability and they were also statistically significantly influenced by fat type in rusk samples and days of storage (Table 3). ANOVA test showed that the days of storage (0, 60, 180 and 360) statistically significantly decreased the hardness of both rusk samples, with fat 1 and fat 2 (Table 3) and statistically significantly decreased fracturability of rusk samples with both types of used fats. Rusk samples with fat 1 had higher hardness and fracturability compared torusk samples with fat 2. During storage period of 360 days, rusk samples with fat 1 and fat 2 had decreased hardness for 16% and 11.2%, respectively, while fracturability of rusk samples with fat 1 and fat 2 decreased for 39.9% and 26.8%, respectively.

Table 3. Texture quality of rusk samples produced with different fat types

Sample	Days of storage			
	0	60	180	360
				Hardness (g)
Rusk sample with fat 1	3585,7±27,1[a]	3539,5±10,2 [b]	3423,8±13,6 [c]	3010,8±9,4[d]
Rusk sample with fat 2	2248,4±10,6[e]	2215,7±11,7[e]	2097,5±8,9[f]	1995,1±11,6[g]
				Fracturability (mm)
Rusk sample with fat 1	1,78±0,05[a]	1,70±0,02[ab]	1,59±0,08[b]	1,07±0,10[c]
Rusk sample with fat 2	0,82±0,09[d]	0,76±0,05[de]	0,69±0,04[ef]	0,60±0,07[f]

[abcdefg]Different letters in the superscript in two rows regarding hardness and in two rows regarding fracturability indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

Concerning its contribution to mouth feel, significantly more favorable characteristics of hardness and fracturability are detected in rusk samples with fat 2. In Serbia, in baker's practice rusk shelf-life should be at least 6 month. It is experienced that rusk keeping quality mostly depends on fat deterioration. Changes can be detected by sensor or chemical tests. In common practice changes in peroxides and acidity are in good correlation with sensor evaluation. According to rusk processing, fats are undergoing unfavorable changes during storing (PYLER & GORTON [1]), so the research is designed to test the impact of pan release grease along with type of fat incorporated in the rusk dough formula. Therefore peroxides and acidity are tested in whole rusk piece (slice), in the centre of rusk piece (part not in contact with pan release grease) and in the crust which was in the contact with pan release grease (1 cm of adhering extent).Average values and their standard deviation of the peroxides of the tested samples without and with multiple pan greasing with fat 1 and with fat 2 during experiment, from different part of the rusk, stored during different period of time, are presented in table 4 and 5.

Table 4. Peroxides (mg O2/kg) of tested rusk samples without and with multiple pan greasing with fat 1 during storage

Sample	Days of storage			
	0	60	180	360
Without greasing				
Whole rusk	0.00±0.00[a]	0.00±0.00[a]	0.01±0.00[a]	0.03±0.00[a]
Center of rusk	0.00±0.00[a]	0.00±0.00[a]	0.01±0.00[a]	0.02±0.01[a]
Rusk crust	0.00±0.00[a]	0.03±0.01[a]	0.03±0.01[a]	0.68±0.11[c]
With multiple greasing				
Whole rusk	0.00±0.00[a]	0.02±0.01[a]	0.01±0.00[a]	0.56±0.09[d]
Center of rusk	0.00±0.00[a]	0.01±0.00[a]	0.01±0.00[a]	0.12±0.05[b]
Rusk crust	0.03±0.01[a]	0.03±0.01[a]	0.12±0.03[b]	1.08±0.13[e]

[abcde]Different letters in the superscript in the table indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

There are no significant statistical differences between peroxides of the samples immediately after the process of production and even after 180 days of storage, as also stated by FILIPOVIĆ & al. [9] (except for peroxides of the rusk crust samples with multiple pan greasing), thus pointing at good oxidative stability of both types of fat incorporated in rusk dough and adverse contribution of pan release. Differences in peroxides start to be noticeable in tested samples after defined periods of storage. Only storage period of 360 days has statistically significantly influenced the increase of the peroxides in all groups of tested samples (without/with multiple greasing, different parts of analyzed rusk slices). Technological operation of pan greasing has influenced the increase of the peroxides, statistically insignificantly after 0 and 60 days of storage, while statistically significantly after 180 and 360 days, thus emphasizing the contribution of pan release grease impact. This data are in accordance with sensory tests, figure1 and results published by PAJIN & al. [4]. Concerning samples from different locations of the rusk (crust, center) stored 360 days, have shown significant statistical differences between peroxides. The highest values were detected in samples of rusk crust where the pan release grease impact was the greatest and the lowest values were in the samples of center of the rusk piece, as also stated by FILIPOVIĆ & al. [3].

Table 5. Peroxides (mg O2/kg) of tested rusk samples without and with multiple pan greasing with fat 2 during storage

Sample	Days of storage			
	0	60	180	360
Without greasing				
Whole rusk	0.00 ± 0.00^{a}	0.13 ± 0.04^{b}	$0.21\pm0.05^{b,c}$	0.43 ± 0.04^{d}
Center of rusk	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.13 ± 0.03^{b}	$0.25\pm0.07^{c,e}$
Rusk crust	0.00 ± 0.00^{a}	$0.05\pm0.01^{a,b}$	$0.21\pm0.03^{b,e}$	0.57 ± 0.08^{f}
With multiple greasing				
Whole rusk	0.00 ± 0.00^{a}	0.10 ± 0.01^{b}	$0.55\pm0.04^{f,g}$	0.65 ± 0.05^{f}
Center of rusk	0.00 ± 0.00^{a}	0.01 ± 0.01^{a}	$0.22\pm0.07^{c,e}$	0.46 ± 0.09^{d}
Rusk crust	0.00 ± 0.00^{a}	0.13 ± 0.06^{b}	$0.47\pm0.09^{d,g}$	1.29 ± 0.12^{h}

^{abcdefgh} Different letters in the superscript in the table indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

Regarding sample location of the rusk, the increase of the peroxides is the most noticeable after 360 days of storage. Comparing ratio of peroxides of the samples of rusk crust with samples of rusk center without and with multiple greasing it can be seen that ratio of samples without greasing is 2.28 compared to 2.81 of the samples with multiple greasing. This results point that higher deposition of pan release grease on the rusk crust was contributing to higher values of peroxides after longer periods of storage. By comparing peroxides in rusk samples with different fats, on the whole, numeric values are slightly higher in rusk with fat 2 pointing at better oxidative stability of fat 1. As acidity of rusk is easy for routine control, its changes during storage were tested in samples with incorporated fat 1 and fat 2 without and with multiple pan greasing and from different parts of the rusk, stored during different period of time, are presented in table 6 and table 7 respectively. Values ranged from 1.74±0.28 to 3.06±0.14 and 1.70±0.01 to 3.56±0.14, respectively.

Table 6. Acidity (ml 0.1 M NaOH) of tested rusk samples without and with multiple pan greasing with fat 1 during storage

Sample	Days of storage			
	0	60	180	360
Without greasing				
Whole rusk	1.81 ± 0.06^{a}	1.89 ± 0.12^{ab}	2.01 ± 0.05^{bc}	2.35 ± 0.15^{d}
Center of rusk	1.70 ± 0.01^{a}	1.83 ± 0.03^{ab}	1.93 ± 0.03^{abe}	2.09 ± 0.09^{ce}
Rusk crust	1.84 ± 0.05^{ab}	1.91 ± 0.10^{abef}	2.03 ± 0.05^{be}	2.37 ± 0.15^{d}
With multiple greasing				
Whole rusk	2.23 ± 0.13^{deg}	2.28 ± 0.08^{dh}	2.39 ± 0.23^{d}	3.04 ± 0.16^{i}
Center of rusk	1.79 ± 0.10^{a}	2.17 ± 0.07^{cdfj}	2.00 ± 0.08^{bej}	2.25 ± 0.15^{de}
Rusk crust	2.13 ± 0.20^{cfgh}	2.42 ± 0.05^{d}	2.50 ± 0.10^{d}	3.06 ± 0.14^{i}

^{abcdefghij} Different letters in the superscript in the table indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

Regardless fat type in the dough, immediately after the process of production (0 days of storage), there was significant statistical difference between values of acidity of rusk crust and center of the rusk in both cases (with and without pan greasing) probably due to the acidity of compounds generated in the crust during baking (PYLER & GORTON [1]).

Storage period of 60, 180 and 360 days has statistically significantly influenced the increase of the acidity in all groups of tested samples (without/with multiple greasing, different parts of analyzed rusk), the same as experienced for peroxides.

Technological operation of pan greasing has influenced the statistically significant increase of the acidity of samples with fat 1 and statistically insignificant increase with fat 2 pointing to the interaction between two fats: in the dough and pan release.

Samples from different locations of the rusk have shown significant statistical differences between acidity, where the highest values were detected in samples of rusk crust and the lowest values were in the samples of center of the rusk. The increase of the acidity regarding sample location of the rusk is the most noticeable after 360 days of storage, the same as for peroxides.

Table 7. Acidity (ml 0.1 M NaOH) of tested rusk samples without and with multiple pan greasing with fat 2 during storage

Sample	Days of storage			
	0	60	180	360
Without greasing				
Whole rusk	1.86 ± 0.20^{a}	2.06 ± 0.06^{ab}	2.39 ± 0.19^{c}	2.80 ± 0.30^{d}
Center of rusk	1.74 ± 0.28^{a}	1.95 ± 0.14^{ae}	2.14 ± 0.04^{bcef}	2.44 ± 0.14^{c}
Rusk crust	2.06 ± 0.30^{ae}	2.18 ± 0.10^{bceg}	2.40 ± 0.10^{c}	2.93 ± 0.08^{dh}
With multiple greasing				
Whole rusk	1.98 ± 0.02^{afgi}	2.11 ± 0.15^{afgj}	2.32 ± 0.06^{cj}	3.25 ± 0.25^{k}
Center of rusk	1.83 ± 0.05^{a}	1.94 ± 0.05^{afg}	2.16 ± 0.10^{bceij}	3.14 ± 0.19^{hk}
Rusk crust	2.05 ± 0.05^{afg}	2.35 ± 0.06^{cj}	2.70 ± 0.12^{d}	3.56 ± 0.14^{l}

^{abcdefghijkl}Different letters in the superscript in the table indicate on statistical significant difference between values at the level of significance of $p<0.05$ (based on post-hoc Fisher LSD test)

By comparing acidity in rusk samples with different fats, on the whole, numeric values are slightly higher in rusk with fat 2 pointing at possibly greater interaction with deposited pan release grease, as well as, to better oxidative stability of fat 1.

According to PRINCIPLES AND GUIDELINES FOR THE ESTABLISHMENT AND APPLICATION OF MICROBIOLOGICAL CRITERIA RELATED TO FOODS [21], following microorganisms were tested in rusk samples: *Enterobacteriaceae*, Yeasts and moulds *Bacillus cereus*. The results of microbiological profile testing of rusk samples with two different fat types, with or without multiple greasing and during 360 days of storage are shown in table 8.

Table 8. Microbiological parameters of tested rusk samples without and with multiple pan greasing with two fat types during storage

Sample	Days of storage			
	0	60	180	360
Rusk sample with fat 1, without greasing (CFU/g)				
Enterobacteriaceae,	<10	<10	<10	<10
Yeasts and moulds	<10	<10	<10	<10
Bacillus cereus	<10	<10	<10	<10
Rusk sample with fat 1, with multiple greasing (CFU/g)				
Enterobacteriaceae,	<10	<10	<10	<10
Yeasts and moulds	<10	<10	<10	<10
Bacillus cereus	<10	<10	<10	<10
Rusk sample with fat 2, without greasing (CFU/g)				
Enterobacteriaceae,	<10	<10	<10	<10
Yeasts and moulds	<10	<10	<10	<10
Bacillus cereus	<10	<10	<10	<10
Rusk sample with fat 2, with multiple greasing (CFU/g)				
Enterobacteriaceae,	<10	<10	<10	<10
Yeasts and moulds	<10	<10	<10	<10
Bacillus cereus	<10	<10	<10	<10

It can be seen that in all cases there were less than 10 colony forming units per 1g (CFU/g) of tested sample, indicating that there were no influence of fat type, technological operation of greasing or storage duration on microbiological profile of tested rusk samples. Due to it's low water activity values all samples were microbiologically safe for consumption, even after 360 days of storage. Microbiological profile also prove not to be responsible for changes in acidity.

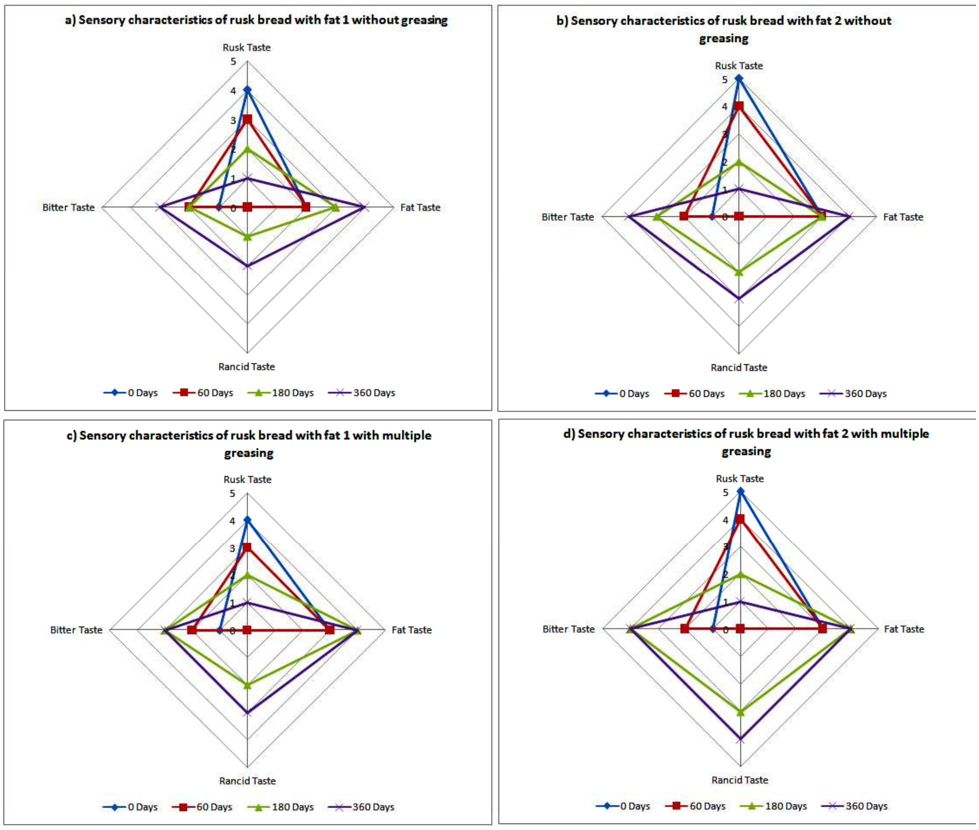

Fig. 1 a-d. The influence of pan greasing on sensory characteristics of rusk taste containing two different fats during storage

On figure 1 change of descriptive sensory characteristics of rusk bread taste during storage are shown. Data point that at the beginning of the storage period (0 days) all rusk samples had very strong, adequate, taste on rusk. Inadequate, rancid and bitter taste were not significant (in case of rancid taste values of descriptors were 0 in all cases, in case of bitter taste values of descriptors were 1 in all cases). Fat taste was present in all samples at the beginning of the storage period, where fat 2 had greater influence on fat taste. With the increase of storage duration descriptor values for rusk taste declined in all samples (all samples had descriptor value of 1 at the 360 days storage period). Descriptor values for rancid and bitter, as negative component of taste, had increased in all tested samples to the very high values at the end of the storage period. These data point at development of off flavors as a result of oxidation. Off flavors probably derived from reversion of fats added to the bread dough and fats experienced in applied pan release grease. The speed of development of this type of off flavors is particularly related to the presence of pan release grease. Fat taste had slightly increased during 360 days of storage period in all tested samples.

The influence of different types of fat used in rusk production had shown that fat 2 had more positive influence on all taste descriptors in shorter periods of storages.

The influence of multiple greasing is noticeable in samples stored during longer periods (180 and 360 days). After these periods of storage rusk samples with both types of fat used, without multiple greasing, had shown less deterioration of taste descriptors than rusk samples with multiple greasing.

Result of descriptive sensory characteristics of tested rusk samples have confirmed presented results of peroxides and acidity of tested rusk samples, and also prove to be more selective than chemical tests commonly used for testing the adverse changes in products with higher or high fat content.

Score analysis quantifies different analyzed characteristics of rusk samples in dimensionless values that represent score values which are comparable between each other. In that way score values allow the possibility of comparing total quality characteristics of different rusk samples.

On figure 2. Score values of rusk samples with two fat types, without multiple pan greasing, during 360 days of storage are shown.

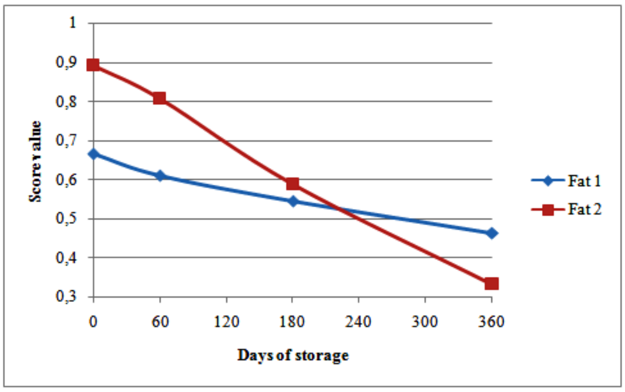

Fig. 2. Score values of tested rusk samples during 360 days of storage

From presented score results it can be seen that duration of storage significantly decreases score samples produced with fat 1 had higher score values, hence higher total quality, while after storage of 360 days, quality of rusk samples with fat 2 decreased more significantly in comparison to the rusk samples produced with fat 1.

Conclusions

This research shows that in case of double baked alveolar products such as rusk, lipid oxidation occurs during storage, but the extent is closely related to the characteristics of applied fats, both in dough formula and pan release.Compound fat type significantly affects texture, color and sensor characteristics of rusk. More favorable is compound fat based on lard.Multiple pan greasing is the crucial step toward lipid changes causing off flavors during rusk shelf-life. Under the same storing conditions, the influence of multiple greasing is noticeable in samples stored during periods longer than 6 month. After these period of storage rusk samples with both types of fat used, without multiple greasing, had shown less deterioration of taste descriptors than rusk samples with multiple greasing, thus emphasizing the adverse contribution of pan release grease deposition to rusk shelf-life. Rusk sample with fat 2 had better technological quality (colour and texture characteristics) during storage up to 180 days, while quality of rusk samples produced with fat 1 was better after 360 days. All tested rusk samples were microbiologically safe for consumption, even after 360 days of storage.

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