Production of Ras Cheese Analogue by Partially or Totally Substitution of Milk Fat with Palm Oil

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ABSTRACT

Production of Ras Cheese with partially or totally substitution of milk fat with palm oil was investigated. The produced imitation Ras cheese was stored for ripening at 12ºC ±2 for 3 months. Tests were carried out when fresh and after 30, 60 and 90 days. Compositional quality tests included the determination of moisture%, total protein, fat, ash and salt, as well as qualitative tests included titratable acidity, pH, soluble nitrogen, free amino acids, free fatty acids, texture profile analysis and microbiological analyses were carried out during cheese ripening. The sensory evaluation was carried out at the end of ripening period (90 days).

The results showed that replacing milk fat with successive ratios of palm oil resulted in a considerable increase in moisture content, consequently total solids were dropped. As the storage period progressed, the percentages of fat, total protein, salt, and ash were increased. The free fatty acids and the soluble nitrogen had a negative correlation with the replacing of milk fat with palm oil. Through the 90 days ripening period, hardness, cohesiveness, springiness, gumminess, and chewiness of the product have been increased. Complete replacing of milk fat with palm oil decreased the flavor acceptability while replacing of 2% milk fat with palm oil was not sensible and has no effect on the overall acceptability. Therefore, adulteration of milk fat with palm oil up to 2% in the milk for manufacturing of Ras cheese cannot be detected by costumers. This issue needs more focusing of authorities to avoid such jugglery in Ras cheese markets.

Key words: ***Ras cheese, palm oil, Texture profile analysis, Microbiological, sensory evaluation*****.**

INTRODUCTION

Ras cheese is a renowned hard cheese in Egypt, the Middle East, and North Africa (Phelan *et al.,* 1993 and El-Sayed, 2020). It is a raw cow's or buffalo's milk-based cheese that is fermented using native microflora and is often made in enormous numbers of small rudimentary factories, similar to several classical Mediterranean cheese types (Awad *et al.,* 2003 and El-Shibiny *et al.,* 2018). Various microbiological and biochemical changes occur during the ripening process. (McSweeney, 2004), which normally allows viable probiotic bacteria to be present in the final products (Fathi & Dabiza, 2005, Khaled *et al*., 2015 and Hao *et al.,* 2021). It takes a long time to be ripened cheese and achieve its full flavor and texture (matured cheese). Cheeses are placed in the ripening rooms of the manufacturing area. They ripen under a generally steady relative humidity (90–95%) and temperature (9–12°C) (El-Fadaly *et al*., 2015). Imitation cheese has become a popular alternative to natural cheese in the food sector (Kiely *et al.,* 1991; Taranto & Yang, 1981; John & O'Riordan, 2008 and Grand View Research, 2021).

Cheese analogues are products created by combining various components, such as nondairy lipids or proteins, to create a cheese-like product that fits specified needs. They're getting more popular as a result of their low cost, which can be ascribed to the ease with which they're made and the use of cheaper vegetable products in place of specific milk ingredients. Sales of cheese analogues are directly tied to advancements in the convenience food industry, where they boost supply while lowering costs. Furthermore, consumers are increasingly interested in foods that are lower in total fat, saturated fat, cholesterol, and calories. (Hans, 2001; El Neenay *et al.,* 2013; Mohamed & Shalaby, 2016; Oyeyinka *et al.,* 2019; Sumarmono *et al.,* 2021 and Rahul *et al.,* 2022).

Palm oil (PO) is a healthy vegetable oil contains blend of unsaturated fatty acids mostly oleic acid (about 40%) and saturated fatty acids mostly palmitic acid (about 45%) obtained from the mesocarp of oil palm fruits. PO is the world's most frequently used vegetable oil, as well as a commercially essential and flexible raw resource for both food and non-food items (Dian *et al.,* 2017; Abdulnaser *et al.,* 2022 and Kumar *et al.,* 2022). Palm oil is one of the most extensively utilized oils by

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food makers due to its unique oxidative stability, distinctive solid content profile, high nutritional value, lack of trans-fatty acids and cholesterols, antioxidant characteristics, and non-genetically modified status (Choo, 2013). As a result, PO-based food products have a long shelf life and a low rate of rancidity. PO does not need to be hydrogenated before being employed in food compositions because it is semi-solid in nature. Hydrogenation is a process that creates trans-fatty acids while increasing the saturated fatty acid content of liquid oil (Noor *et al.,* 2017). Many dairy products, including ice cream (Berger, 1989; Wan and Nor, 2000 ; Sung and Goff, 2010), Feta cheese (Abed El Malek *et al.*, 2019), and Milk (Berger, 1989; Wan and Nor, 2000; Sung and Goff, 2010), have used PO as a substitute of milk fat (Khorsandmanesh *et al*., 2020). About usage of PO in the making of Ras cheese, there is lack of information. The purpose of this research was to study for what extent the palm oil may be used as a natural fat substitute in the making of Ras cheese analogues.

MATERIALS AND METHODS

Materials:

Raw whole cow milk was obtained from the dairy herd at the farm of the faculty of agriculture, Alexandria University, Egypt. Palm oil was obtained from the local market.

Starter culture; which consists *of Streptococcus salivarius subsp. thermophillus* and *Lactobacillus delbruckii subsp. bulgaricus* (YF-L812-Chr. Hansen's Lab A/s Copenhagen, Denmark) were used. Rennet powder (Hanelase) was obtained from Chr. Hansen's Lab., Denmark. Fine cooking salt produced by EL-Naser Saline's Company was obtained from the local market.

Cheese manufacture

The experimental design was performed to study the effect of palm oil as milk fat substitute in manufacturing of Ras cheese analogues. Seven different treatments of Ras cheese analogues and control were; Control, 3.5% milk fat without palm oil; T1, 1% palm oil + 2.5% milk fat; T2, 1.5% palm oil + 2% milk fat; T3, 2% palm oil + 1.5% milk fat; T4, 2.5% palm oil + 1% milk fat; T5, 3% palm oil + 0.5% milk fat and T6: 3.5% palm oil without milk fat.

Ras cheese analogues treatments were manufactured according to the method adopted from Hofi *et al.* (1970). Resultant cheese was stored at 12ºC ±2 for 3 months. All cheese treatments were sampled and analyzed when fresh, at 1, 2 and 3 months for chemical, rheological, microbiological properties. The whole experiment was triplicates.

Methods of analysis:

Cheese moisture, protein, SN, fat, salt, ash contents, pH value and titratable acidity were determined according to AOAC (2000). Free amino acids were measured in cheese as described by Fields (1971), and applied to cheese by Kuchroo *et al*. (1983). Free fatty acids were measured in cheese as described by (Deeth and Fitz-Gerald, 1975). Texture profile analysis (TPA) of Ras cheese samples was measured at 23ºC as described by Bourne (1978). Coliform, yeast and molds were detected as described by (APHA, 1992). Sensory evaluation of cheese was carried at the end of ripening period (90 days) according to the method of Shalaby *et al.* (2016). All data were analyzed by the General Linear Models procedure of SAS (2000)**.** Least significant difference test was performed to determine differences in means at $P \leq 0.05$.

RESULTS and DISCUSSION

Physiochemical Characterization of Ras Cheese analogues:

Table 1 shows the chemical composition of Ras cheese substitutes used to replace milk fat during ripening for up to 3 months. The results show that among the treatments, cheese control (zero palm oil) had the lowest moisture content, while Ras cheese analogues with 3.5 percent PO (T6) had the greatest. Because the nonpolar residues -casein have a significant tendency to be adsorbed at the oil/water interface (Wicek and Chibowski, 2005), a positive correlation was seen between varied degrees of substituted milk fat with palm oil and moisture in fresh Ras cheese analogues. The use of PO as a milk fat substitute had a substantial impact on the overall protein and fat levels of the resulting Ras cheese alternatives. Increasing the PO ratio resulted in decreased protein and fat values. In addition, while using PO as a fat substitute, the ratio of ash and salt was lower than in the control treatment.

During ripening, the moisture content of Ras cheese analogues decreased significantly; the cause of this loss could be linked to salting. During the ripening process, the protein, fat, salt, and ash contents gradually increase. This may be due to the second stage of salting that occurred in the process. The results are consistent with those originally published (Hofi *et al.,* 1970; El-Fadaly *et al.,* 2015 and Abed El Malek *et al.,* 2019).

Table 1. The chemical composition of Ras cheese analogues is affected by the rate of palm oil used in fresh and during storing

Component	S.P	Treatments*							Mean ± SD
	(day)	C	T1	T2	T3	T4	T5	T6	
	Fresh	$^{a}35.64^{g}$	$^{a}36.45^{f}$	$^{a}37.30^{e}$	$^{a}38.16^{d}$	$^{a}39.10^{c}$	$^{a}40.09^{b}$	$^{a}41.77a$	$38.36^{a}\pm2.14$
Moisture%	30	$^{b}32.55^{g}$	$^{b}33.45^{f}$	$^{b}34.30^{e}$	$^{b}34.76^{d}$	$^{b}35.10^{c}$	$^{b}36.39^{b}$	$^{b}37.87^{a}$	$34.92^{b}\pm1.78$
	60	$^{c}29.36^{f}$	$^{c}30.26^{e}$	$^{c}30.39^{e}$	$^{c}31.57^{d}$	$^{c}31.91^{c}$	$^{c}33.19^{b}$	$^{c}34.67^{a}$	$31.62^{c}\pm1.84$
	90	$^{d}25.97^{e}$	$^{d}26.87^{d}$	$^{d}27.01^{d}$	$^{d}28.16^{c}$	$^{d}28.52^{c}$	$^{d}29.80^{b}$	$^{d}31.28^{a}$	$28.23^{d}\pm1.84$
Mean ±SD		$30.88^{g}\pm$ 4.161	$1131.76^{f}\pm$ 4.131	$32.25^{e}\pm$ 4.50	$33.16^{d}\pm$ 4.28	$33.66^{c}\pm$ 4.52	$34.88^{b}\pm$ 4.39	$36.40^{a}\pm$ 4.48	
	Fresh	$^{d}27.90^{a}$	$^{d}26.70^{b}$	$^{d}25.60^{c}$	$^{d}24.30^{d}$	$^{d}22.90^{e}$	$^{d}21.30^{f}$	$^{d}19.40^{g}$	$24.06^{d}\pm3.05$
Protein	30	$^{c}28.80^{a}$	$^{c}27.80^{ab}$	$^{c}26.80^{ab}$	$^{c}25.70^{ab}$	$^{c}24.40^{bc}$	$^{c}23.00^{bc}$	$^{c}21.30^{c}$	$24.93^{c}\pm2.47$
/ DM%	60	$^{b}29.90^{a}$	$^{b}29.00^{b}$	$^{b}28.10^{c}$	$^{b}27.10^{d}$	$^{b}25.90^{e}$	$^{b}24.60^{f}$	$^{b}23.00^{g}$	$26.80^{b}\pm2.46$
	90	$^{a}32.00^{a}$	$^{a}31.20^{b}$	$^{a}30.40^{c}$	$^{a}29.50^{d}$	$^{a}28.40^{e}$	$^{a}27.20^{f}$	$^{a}25.70^{g}$	$29.20^{a}\pm2.25$
Mean ±SD		$29.65^{a}\pm$ 1.77	$27.84^{b}\pm$ 2.90	$27.81^{b}\pm$ 1.94	$26.67^{c}\pm$ 2.21	$25.40^{d}\pm2.$ 35	$24.03^{e}\pm$ 2.51	$22.35^{f}\pm$ 2.67	
	Fresh	$^{d}28.50^{a}$	$^{d}28.50^{a}$	$^{d}28.00^{b}$	$^{d}27.00^{c}$	$^{d}26.50^{d}$	$^{d}25.00^{e}$	$^{d}24.00^{f}$	$26.79^{d}\pm1.75$
Fat	30	$^{c}30.00^{a}$	$^{c}29.50^{b}$	$^{c}29.00^{c}$	$^{c}28.00^{d}$	$^{c}27.50^{e}$	$^{c}26.50^{f}$	$^{c}25.00^{g}$	$27.93^{c}\pm1.77$
/ DM%	60	$^{b}32.00^{a}$	$^{b}31.50^{a}$	$^{b}30.00^{b}$	$^{b}29.00^{c}$	$^{b}28.50^{cd}$	$^{b}28.00^{d}$	$^{b}27.00^{e}$	$29.43^{b}\pm1.84$
	90	$^{a}32.50^{a}$	$^{a}32.50^{a}$	$^{a}31.50^{b}$	$^{a}31.00^{c}$	$^{a}30.00^{d}$	$^{a}29.00^{e}$	$^{a}29.00^{e}$	$30.79^{a}\pm1.50$
Mean ±SD		$30.75^{a}\pm$ 1.85	$30.50^{b}\pm$ 1.83	$29.63^{c}\pm$ 1.49	$28.75^{d}\pm$ 1.71	$28.13^{e}\pm$ 1.49	$27.13^{f}\pm$ 1.75	$26.25^{g}\pm$ 2.22	
	Fresh	$^{d}0.93^{a}$	$^{d}0.91^{ab}$	$^{d}0.87^{b}$	$^{d}0.82^{c}$	$^{d}0.76^{d}$	$^{d}0.68^{e}$	$^{d}0.52^{f}$	$0.78^{d}\pm0.15$
Salt	30	$^{c}1.53^{a}$	$^{c}1.42^{b}$	$^{c}1.34^{c}$	$^{c}1.20^{d}$	$^{c}1.14^{d}$	$^{c}0.96^{e}$	$^{c}0.81^{f}$	$1.20^{c}\pm0.26$
/ DM%	60	$^{b}2.14^{a}$	$^{b}2.04^{b}$	$^{b}1.93^{c}$	$^{b}1.78^{d}$	$^{b}1.71^{e}$	$^{b}1.53^{f}$	$^{b}1.37^{g}$	$1.79^{b}\pm0.28$
	90	$^{a}2.86^{a}$	$^{a}2.77^{b}$	$^{a}2.67^{c}$	$^{a}2.52^{d}$	$^{a}2.46^{e}$	$^{a}2.29^{f}$	$^{a}2.14^{g}$	$2.53^{a}\pm0.26$
Mean ±SD		$1.87^{a}\pm$ 0.83	$1.79^{b}\pm$ 0.80	$1.70^{c}\pm$ 0.78	$1.58^{d}\pm$ 0.74	$1.52^{e}\pm$ 0.74	$1.37^{f}\pm$ 0.71	$1.21^{g}\pm$ 0.71	
	Fresh	$^{c}5.67^{a}$	$^{c}5.34^{b}$	$^{c}4.94^{c}$	$^{c}4.48^{d}$	$^{c}3.99^{e}$	$^{c}3.47^{f}$	$^{c}2.89^{g}$	$4.40^{c}\pm1.01$
Ash	30	$^{bc}5.78^{a}$	$^{bc}5.46^{b}$	$^{c}5.07^{c}$	$^{c}4.62^{d}$	$^{c}4.14^{e}$	$^{c}3.63^{f}$	$^{c}3.06^{g}$	$4.54^{bc}\pm0.99$
/ DM%	60	$^{b}5.99^{a}$	$^{b}5.68^{b}$	$^{b}5.30^{c}$	$^{b}4.86^{d}$	$^{b}4.39^{e}$	$^{b}3.89^{f}$	$^{b}3.34^{g}$	$4.78^{ab}\pm0.96$
	90	$^{a}6.31^{a}$	$^{a}6.01^{b}$	$^{a}5.64^{c}$	$^{a}5.21^{d}$	$^{a}4.75^{e}$	$^{a}4.26^{f}$	$^{a}3.72^{g}$	$5.13^{a}\pm0.94$
Mean ±SD		5.94^{a} ±0.28	5.62^{b} ±0.29	5.24^{c} ±0.31	4.79^{d} ±0.32	4.32^{e} ±0.33	3.82^{f} ±0.34	3.25^{g} ±0.36	

*Means of triplicates. Means followed by the same superscript are not significantly different at $P \leq 0.05$. Control: Ras cheese made using 0%palm oil + 3.5% milk fat, T1: Ras cheese analogue made using 1% palm oil + 2.5% milk fat, T2: Ras cheese analogue made using 1.5% palm oil + 2% milk fat, T3: Ras cheese analogue made using 2% palm oil + 1.5% milk fat, T4: Ras cheese analogue made using : 2.5% palm oil + 1% milk fat, T5: Ras cheese analogue made using 3% palm oil + 0.5% milk fat, T6: Ras cheese analogue made using 3.5% palm oil + zero milk fat.

Figure (1 and 2) depicts the changes in titratable acidity and pH values of Ras cheese mimics over time. According to the statistics, the acidity of control cheese (full milk fat without palm oil) was the greatest. The acidity value of Ras cheese mimics prepared with 3.5 percent palm oil and no milk fat (T6) was lower than the other treatments. It was clear from the results that lowering the fat content of cheese milk and adding palm oil reduced the acidity of the resulting cheese. This could be due to the fact that some treatments have a higher moisture content. Our results are consistent with El- Fadaly *et al.,* (2015). The changes in pH value across all cheese treatments and over time followed the opposite trend as titratable acidity. This means that the pH of palm oil treatments was higher than the control when they were fresh and during the storage period.

The effects of PO on the soluble nitrogen (SN) concentration of Ras cheese analogues during storage for up to three months are shown in Fig (3). By adding PO in all cheeses, SN was reduced. The rate of free fatty acids and the levels of soluble nitrogen had a negative association by replacing of milk fat with palm oil. Throughout the ripening phase, the SN content of all cheese treatments, including the control, increased. These findings are consistent with those reported by El-Fadaly *et al.,* (2015).

The changes in Free Amino Acids (FAA) of Ras cheese mimics over time are depicted in Figure (4). According to the findings, control cheese had the

highest FAA value. T6 had a lower FAA value than the other treatments. From the data, it is clear that a lower protein content of cheese leads in a lower value of FAA in the final cheese; this could be ascribed to the higher moisture content of these treatments, and our findings support this theory. Our findings are consistent with (El Fadaly *et al.*, 2015). Changes in the value of free fatty acids (FFA) in all cheese treatments during the fresh and storage periods Fig (5). The FFA values of treatments with palm oil were lower than control while fresh and throughout the storage period, following the opposite trend as FAA. It is possible to deduce from the data that a lower fat content of cheese results in a lower value of FFA in the resulting cheese. Our findings are consistent with (El Fadaly *et al.*, 2015 and Abed El Malek *et al.*, 2019).

Microbiological quality of Ras cheese analogues:

Yeast and molds and coliform counts are shown in Table (2). They increased during three months of ripening period (Savijoki *et al.*, 2006 & Dabiza and El-Deib, 2007). These results might be due to the increase of moisture content and consequently increase the water activity that enhance the microbial growth and decreasing of oxygen penetration that enhance the growth of lactic acid bacterial (Dabiza & El-Deib, 2007and El-Fadaly *et al.*, 2015). Also Coliform, Mold and Yeast were increasing by increase palm oil and during storage period.

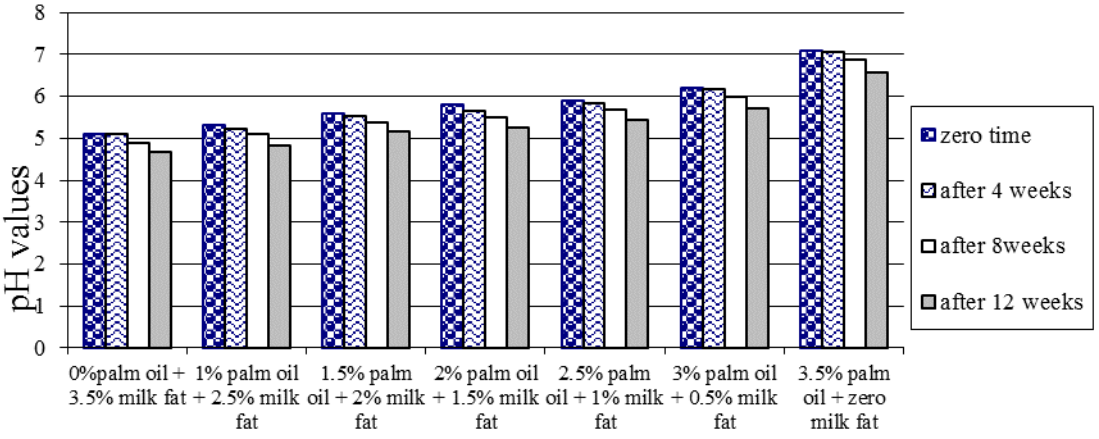


Fig.1. The pH values of Ras cheese analogues as influenced by varied quantities of palm oil during ripenning

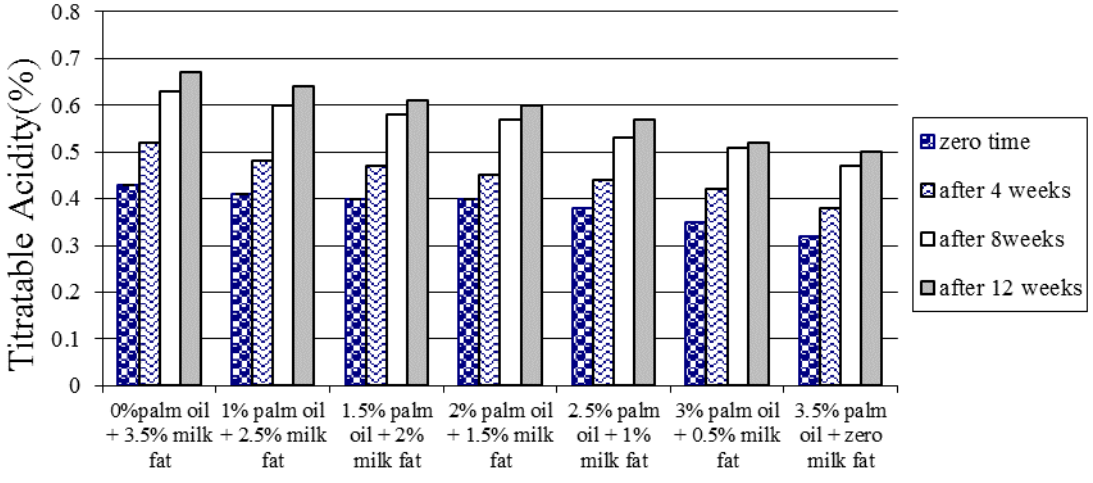


Fig.2. The titratable acidity of Ras cheese analogues as influenced by varied quantities of palm oil during ripenning

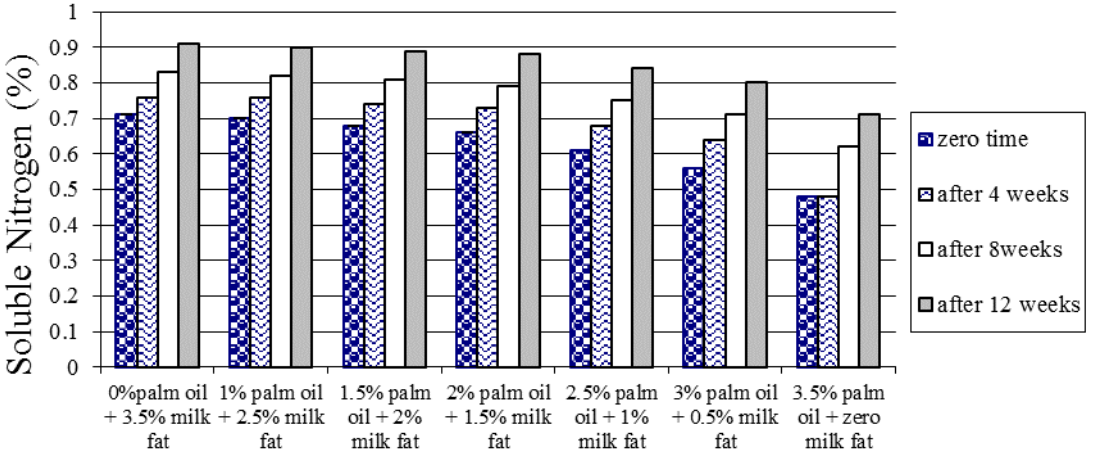


Fig.3. soluble nitrogen (%) of Ras cheese mimics as influenced by varied quantities of palm oil during ripenning

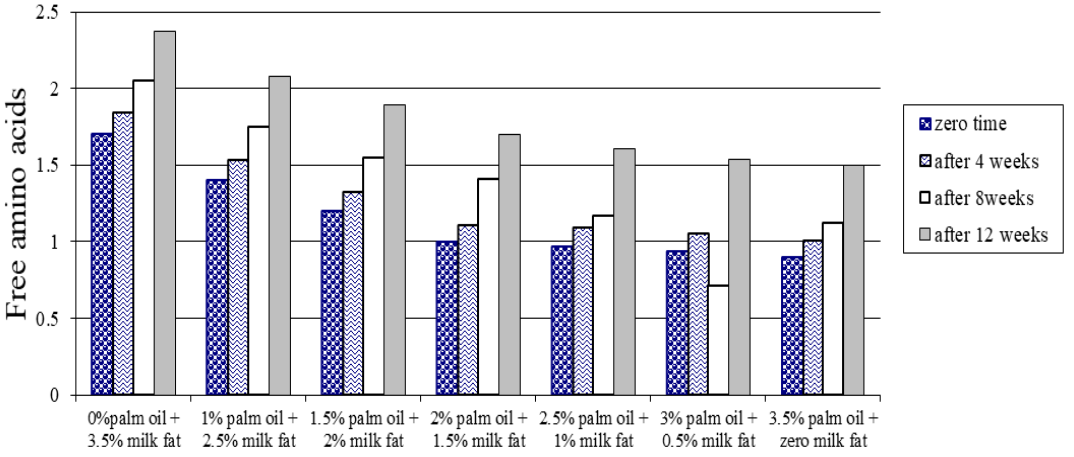
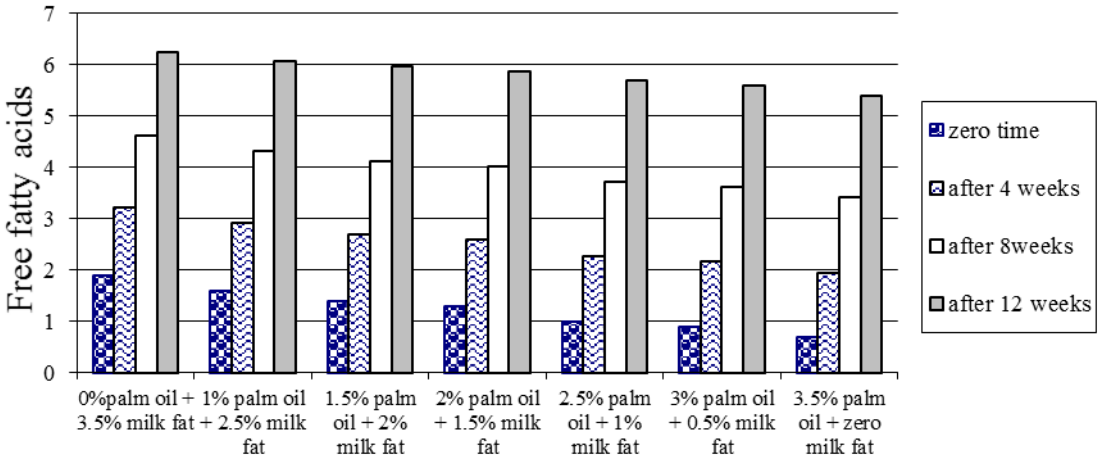


Fig.4 : Free amino acids of Ras cheese analogues as affected by using different levels with palm oil in zero time and during storage period



Fig, 5.Free fatty acids of Ras cheese mimics as influenced by varied quantities of palm oil during ripenning

Table 2. Microbiological counts of Ras cheese analogues as affected by using different levels with palm oil during storage period

	Storage period	Treatments*							
		C	T1	T2	T3	T4	T5	T6	Mean± SD
Yeast & mold (CFU/g)	1 M	$^{c}00.0$	$^{c}00.0$	$^{c}0.00$	$^{c}0.00$	$^{c}0.00$	$^{c}0.00$	$^{c}0.00$	0.00^{c} ±0.00
	2 M	$^{b}20^{b}$	$^{b}20^{b}$	$^{b}20^{b}$	$^{b}30^{a}$	$^{b}30^{a}$	$^{b}30^{a}$	$^{b}30^{a}$	25.71^{b} ±5.35
	3 M	$^{a}30^{c}$	$^{a}40^{b}$	$^{a}40^{b}$	$^{a}40^{b}$	$^{a}50^{a}$	$^{a}50^{a}$	$^{a}50^{a}$	42.86^{a}±7.56
Mean ± SD		16.67^{d} ±15.28	20.00^{c} ±20.00	20.00^{c} ±20.00	23.33^{b} ±20.82	26.67^{a} ±25.17	26.67^{a} ±25.17	26.67^{a} ±25.17	
Coliform (CFU/g)	1 M	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	0.00±0.00
	2 M	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	$^{b}0.00^{b}$	0.00^{b}	$^{b}10^{a}$	$^{b}10^{a}$	2.86±4.88
	3 M	$^{a}10^{e}$	$^{a}10^{e}$	$^{a}20^{d}$	$^{a}30^{c}$	$^{a}30^{c}$	$^{a}40^{b}$	$^{a}50^{a}$	27.14±14.96
Mean ± SD		3.33^{e} ±5.77	3.33^{e} ±5.77	6.67^{d} ±11.55	10.00^{c} ±17.32	10.00^{c} ±17.32	16.67^{b} ±20.82	20.00^{a} ±26.46	

*Means of triplicates. Means followed by the same superscript are not significantly different at $P \leq 0.05$. Control: Ras cheese made using 0%palm oil + 3.5% milk fat, T1: Ras cheese analogue made using 1% palm oil + 2.5% milk fat, T2: Ras cheese analogue made using 1.5% palm oil + 2% milk fat, T3: Ras cheese analogue made using 2% palm oil + 1.5% milk fat, T4: Ras cheese analogue made using : 2.5% palm oil + 1% milk fat, T5: Ras cheese analogue made using 3% palm oil + 0.5% milk fat, T6: Ras cheese analogue made using 3.5% palm oil + zero milk fat.

Texture profile analysis (TPA) of Ras cheese analogues with palm oil:

The force required to puncture the sample with the molar teeth (from soft to firm) is referred to as hardness (Lee *et al.*, 1978). Table (3) shows that replacing milk fat with PO resulted in a decrease in the hardness of fresh cheeses. This could be attributed to an increase in cheese moisture content, which weakens the casein micelles. Springiness is defined by the panellists as the sample's ability to bounce back after many bites. The values obtained for this attribute Table (3) shows that the springiness of Ras cheese analogues with various treatments ranged from 2.2 to 0.92 mm, indicating a decrease in springiness. Cohesiveness is defined as the degree to which a cheese treatment deforms before rupturing; thus, cohesiveness values are a direct function of the amount of work required to break the material's internal linkages. In comparison to the other treatments, treatment (6) with 3.5 percent palm oil had the lowest hardness, adhesiveness, cohesiveness, springiness, gumminess, and chewiness. The number of chews necessary to swallow a given volume of sample is referred to as chewiness. Because this attribute is described mathematically as the product of gumminess and springiness, it follows the same trend as these two properties. These include the temperature of coagulation and whey drain, cheese composition, pH, interactions between casein and serum proteins, calcium content, ionic strength, salt content, and manufacturing process, particularly the pace of acid formation. The cheese's fat content is responsible for its numerous beneficial functional and textural characteristics. Furthermore, decreasing the moisture content after three months may result in a reduction in the amount of free moisture in

the cheese, increasing the hardness (Awad, 2011). During a storage period, hardness, cohesiveness, springiness, gumminess, and chewiness were increase.

Sensory evaluation of Ras cheese analogues:

The method of manufacture, type of fat used in cheese making, salt concentration added, and storage conditions significantly affect on the organoleptic properties of Ras cheese. The organoleptic evaluation of Ras cheese using PO as a milk fat replacement during ripening up to 3 months is shown in Table (4).

Table 3. Texture profile analysis (TPA) of Ras cheese analogues as a function of palm oil levels used in fresh and during storage

	Storage period	Treatments*							Mean± SD
		C	T1	T2	T3	T4	T5	T6	
Hardness G	F	$^{d}473.00^{a}$	$^{d}434.00^{b}$	$^{d}421.00^{c}$	$^{d}395.00^{d}$	$^{d}380.00^{e}$	$^{d}368.00^{e}$	$^{d}351.00^{f}$	403.14^{d}±42.24
	1 M	$^{c}685.00^{a}$	$^{c}578.00^{b}$	$^{c}568.00^{c}$	$^{c}554.00^{d}$	$^{c}534.00^{e}$	$^{c}524.00^{f}$	$^{c}512.00^{f}$	565.00^{c}±57.95
	2 M	$^{b}754.00^{a}$	$^{b}754.00^{a}$	$^{b}745.00^{b}$	$^{b}742.00^{b}$	$^{b}731.00^{c}$	$^{b}687.00^{d}$	$^{b}621.00^{e}$	719.10^{b}±49.01
	3 M	$^{a}1025.00^{a}$	$^{a}952.00^{b}$	$^{a}912.00^{c}$	$^{a}878.00^{d}$	$^{a}785.00^{e}$	$^{a}758.00^{f}$	$^{a}748.00^{f}$	865.43^{a}±105.74
Mean ± SD		637.33^{a} ±146.44	588.67^{b} ±160.27	577.89^{b} ±162.06	563.67^{c} ±173.70	548.33^{d} ±175.94	526.33^{e} ±159.51	494.67^{f} ±135.83	
Adhesiveness	F	$^{d}6.80^{a}$	$^{d}6.10^{b}$	$^{d}5.70^{c}$	$^{d}5.50^{c}$	$^{d}4.80^{d}$	$^{d}4.60^{de}$	$^{d}4.50^{e}$	5.43^{d}±0.85
	1 M	$^{c}11.60^{a}$	$^{c}9.80^{b}$	$^{c}9.20^{c}$	$^{c}8.80^{c}$	$^{c}8.20^{d}$	$^{c}8.20^{d}$	$^{c}8.00^{d}$	9.11^{c}±1.27
	2 M	$^{b}12.16^{a}$	$^{b}12.00^{a}$	$^{b}11.60^{b}$	$^{b}11.20^{c}$	$^{b}10.16^{c}$	$^{b}9.68^{d}$	$^{b}9.92^{cd}$	10.96^{b}±1.03
	3 M	$^{a}14.50^{a}$	$^{a}13.40^{b}$	$^{a}13.20^{b}$	$^{a}12.10^{c}$	$^{a}11.40^{d}$	$^{a}11.20^{d}$	$^{a}10.40^{e}$	12.31^{a}±1.45
Mean ± SD		10.19^{a} ±2.95	9.30^{b} ±2.98	8.83^{c} ±2.97	8.50^{d} ±2.86	7.72^{e} ±2.71	7.49^{e} ±2.61	7.47^{e} ±2.75	
Springiness (mm)	F	$^{d}1.10^{a}$	$^{d}1.10^{a}$	$^{d}1.10^{a}$	$^{d}0.95^{b}$	$^{d}0.94^{bc}$	$^{d}0.92^{c}$	$^{d}0.92^{c}$	1.01^{d}±0.09
	1 M	$^{c}1.40^{a}$	$^{c}1.40^{a}$	$^{c}1.30^{b}$	$^{c}1.20^{c}$	$^{c}1.20^{c}$	$^{c}1.10^{d}$	$^{c}1.00^{e}$	1.23^{c}±0.14
	2 M	$^{b}1.89^{a}$	$^{b}1.84^{a}$	$^{b}1.75^{b}$	$^{b}1.67^{c}$	$^{b}1.65^{c}$	$^{b}1.45^{d}$	$^{b}1.45^{d}$	1.67^{b}±0.17
	3 M	$^{a}2.20^{a}$	$^{a}2.10^{b}$	$^{a}2.10^{b}$	$^{a}1.95^{c}$	$^{a}1.85^{d}$	$^{a}1.78^{e}$	$^{a}1.65^{f}$	1.95^{a}±0.20
Mean ± SD		1.46^{a} ±0.40	1.45^{a} ±0.37	1.38^{b} ±0.33	1.27^{c} ±0.37	1.26^{c} ±0.36	1.16^{d} ±0.27	1.14^{e} ±0.27	
Cohesiveness	F	$^{b}0.84^{a}$	$^{d}0.81^{b}$	$^{b}0.78^{c}$	$^{d}0.75^{d}$	$^{d}0.74^{e}$	$^{d}0.72^{f}$	$^{d}0.71^{f}$	0.76^{d}±0.05
	1 M	$^{a}0.95^{a}$	$^{c}0.83^{b}$	$^{b}0.79^{c}$	$^{c}0.78^{cd}$	$^{c}0.76^{d}$	$^{c}0.73^{e}$	$^{c}0.72^{e}$	0.79^{c}±0.08
	2 M	$^{a}0.95^{a}$	$^{b}0.85^{b}$	$^{a}0.84^{c}$	$^{b}0.81^{d}$	$^{b}0.78^{e}$	$^{b}0.76^{f}$	$^{b}0.74^{g}$	0.82^{b}±0.07
	3 M	$^{a}0.96^{a}$	$^{a}0.86^{b}$	$^{a}0.84^{c}$	$^{a}0.83^{cd}$	$^{a}0.82^{de}$	$^{a}0.81^{ef}$	$^{a}0.80^{f}$	0.85^{a}±0.05
Mean ± SD		0.91^{a} ±0.06	0.83^{b} ±0.02	0.80^{c} ±0.03	0.78^{d} ±0.03	0.76^{e} ±0.02	0.74^{f} ±0.02	0.72^{g} ±0.02	
Gumminess	F	$^{d}397.32^{a}$	$^{d}351.54^{b}$	$^{d}328.38^{c}$	$^{d}269.25^{d}$	$^{d}281.20^{c}$	$^{d}264.96^{d}$	$^{d}249.21^{e}$	305.98^{d}±54.45
	1 M	$^{c}650.75^{a}$	$^{c}450.84^{b}$	$^{c}426.00^{c}$	$^{c}409.96^{d}$	$^{c}405.84^{d}$	$^{c}382.52^{e}$	$^{c}368.64^{c}$	442.08^{c}±95.89
	2 M	$^{b}716.30^{a}$	$^{b}633.36^{b}$	$^{b}633.25^{b}$	$^{b}592.11^{c}$	$^{b}578.76^{d}$	$^{b}508.38^{e}$	$^{b}419.96^{f}$	583.16^{b}±95.81
	3 M	$^{a}984.00^{a}$	$^{a}818.72^{b}$	$^{a}766.08^{c}$	$^{a}728.74^{d}$	$^{a}643.70^{e}$	$^{a}613.98^{f}$	$^{a}598.40^{g}$	736.23^{a}±136.41
Mean ± SD		588.12^{a} ±168.46	478.58^{b} ±142.94	462.54^{c} ±155.69	423.77^{d} ±161.87	421.93^{d} ±149.43	385.29^{e} ±121.73	345.94^{f} ±87.61	
Chewiness	F	$^{d}437.05^{a}$	$^{d}394.06^{b}$	$^{d}386.69^{b}$	$^{d}281.44^{c}$	$^{d}264.33^{d}$	$^{d}243.76^{e}$	$^{d}236.75^{e}$	320.58^{d}±82.62
	1 M	$^{c}911.05^{a}$	$^{c}596.40^{b}$	$^{c}586.09^{b}$	$^{c}535.53^{c}$	$^{c}527.59^{c}$	$^{c}491.95^{d}$	$^{c}442.37^{e}$	584.43^{c}±153.40
	2 M	$^{b}1197.05^{a}$	$^{b}1181.90^{b}$	$^{b}1108.19^{c}$	$^{b}966.53^{d}$	$^{b}858.56_{e}$	$^{b}737.15^{f}$	$^{b}588.73^{g}$	948.30^{b}±232.48
	3 M	$^{a}2164.80^{a}$	$^{a}1719.31^{b}$	$^{a}1608.77^{c}$	$^{a}1421.04^{d}$	$_{a}1190.85^{e}$	$^{a}1092.88^{f}$	$^{a}987.36^{g}$	1455.00^{a}±411.92
Mean ± SD		848.38^{a} 383.85	724.12^{b} 409.15	693.66^{c} 372.58	594.50^{d} 346.33	550.16^{e} 297.76	490.96^{f} 246.70	422.61^{g} 176.82	

*Means of triplicates. Means followed by the same superscript are not significantly different at $P \leq 0.05$. Control: Ras cheese made using 0%palm oil + 3.5% milk fat, T1: Ras cheese analogue made using 1% palm oil + 2.5% milk fat, T2: Ras cheese analogue made using 1.5% palm oil + 2% milk fat, T3: Ras cheese analogue made using 2% palm oil + 1.5% milk fat, T4: Ras cheese analogue made using : 2.5% palm oil + 1% milk fat, T5: Ras cheese analogue made using 3% palm oil + 0.5% milk fat, T6: Ras cheese analogue made using 3.5% palm oil + zero milk fat.

Table 4. Sensory assessment of Ras cheese after 3 months of storage as influenced by varied levels of palm oil

Treatments	Color (10)	Flavor (10)	Texture (10)	Appearance (10)	Overall (10)
Control	8.11^{a}	7.78^{a}	7.78^{a}	8.00^{a}	7.78^{a}
T1	8.00^{a}	7.67^{b}	7.33^{b}	7.67^{b}	7.56^{b}
T2	8.00^{a}	7.11^{c}	7.33^{b}	7.67^{b}	7.53^{b}
T3	7.78^{ab}	6.89^{d}	7.22^{c}	7.56^{bc}	7.53^{b}
T4	7.78^{ab}	6.67^{e}	7.22^{c}	7.33^{cd}	7.34^{c}
T5	7.44^{b}	6.44^{f}	6.78^{d}	7.22^{d}	6.97^{d}
T6	6.67^{c}	5.89^{f}	6.69^{e}	6.33^{e}	6.39^{e}
LSD	0.45	0.032	0.042	0.327	0.040

*Means of triplicates. Means followed by the same superscript are not significantly different at $P \leq 0.05$. Control: Ras cheese made using 0%palm oil + 3.5% milk fat, T1: Ras cheese analogue made using 1% palm oil + 2.5% milk fat, T2: Ras cheese analogue made using 1.5% palm oil + 2% milk fat, T3: Ras cheese analogue made using 2% palm oil + 1.5% milk fat, T4: Ras cheese analogue made using: 2.5% palm oil + 1% milk fat, T5: Ras cheese analogue made using 3% palm oil + 0.5% milk fat, T6: Ras cheese analogue made using 3.5% palm oil + zero milk fat.

CONCLUSION

According to the obtained results, replacing 2% milk fat with palm oil in Ras cheese milk resulted in an increase in moisture and a decrease in hardness of final Ras cheese. The overall quality revealed that the imitation Ras cheese made by replacing up to 2% of the milk fat with PO could not be detected by costumers, and this needs more focusing of authorities to detect the adulterated of Ras cheese in markets.

REFERENCES

Abed El Malek, F. A, S. A. Osman, and N. A. Younis. 2019. Palm Kernel Oil as a Substitute of Milk Fat in Feta Cheese. Journal of Food and Dairy Science, Mansoura University, Vol. 10 (2): 31 – 35.

Abdulnaser, M. A, A. Amin, N. Sajjad, Ehsan Yaghoubi, Wesam Alaloul, A. A. Ramez, I. K. Muhammad and S. A. Y. Nura. 2022. Utilization of palm oil and its by-products in bio-asphalt and bio-concrete mixtures: A review. Construction and Building Materials 337, 127552

AOAC. 2000. AOAC Official Method 920.124: Acidity of Cheese, Titrimetric Method. Association of Official Analytical Chemists, Washington, DC Bourne, M.C. 1982. Texture profile analysis. Food Technology, 32, 62-66,72.

APHA. 1992. American Puplic Health Association, Compendium of Methods for the Microbiological Examination of Foods. Inc. Washington, DC. 499-503.

Awad, S. 2011. Texture and Microstructure. In Practical Food and Research. (Ed. Rui M, Cru S.), Nova Science publishers, Inc. pp. 361-391.

Awad, S. A, E. A. Ayad and M. El-Soda. 2003. Characterisation of Egyptian Ras Cheese. 1. Sensory evaluation, rheological, physico-chemical, properties and microbiological analysis. Egyptian Journal of Dairy Science, 31, 289-303.

Berger, K. G. 1989. The use of palm and palm kernel oil in ice cream and whipped cream products. Palm Oil Development, 10 (1-3).

Bourne, M. 1978. Texture profile Analysis. Food Technology; 32: 62-66, 72.

Bugaud, C., B. Solange and D. Didier. 2001. Influence of the nature of alpine pastures on plasmin activity, fatty acid and volatile compound composition of milk. Journal of Dairy Science and Technology 81(3):401-414.

Choo, Y. M. 2013. Palm oil: a versatile ingredients for food and non-food applications. Presented at the Malaysia-Vietnam Palm Oil Trade Fair and Seminar (POTS) 2013.

Dabiza, N., K. El- Deib. 2007. Biochemical evalution and microbial quality of Ras cheese supplemented with probiotic strains. Polish Journal of Food and Nutrition Science. Vol. 57, No. 3, pp. 295–300.

Deeth, H.C. and C.H. Fitz-Gerald. 1975. A convenient method for determining the extent of lipolysis in milk Australian Journal of Dairy Technology 30(3):109-111.

Dian, N. L. H., R. Abd Hamid, S. Kanagaratnam, W. R. A. Isa, N. A. M. Hassim, N. H. Ismail, Z. Omar and M. MAT Sahri. 2017. Palm Oil and Palm Kernel Oil: Versatile Ingredients for Food Application. Journal of Oil Palm Research. 29 (4): 487 – 511.

El-Fadaly. H. A.1., M. N. F. Hamad, S. M. L. El-Kadi and A. A. Habib. 2015. Effect of Clove Oil on Physicochemical and Microbiological Characteristics of Egyptian Ras Cheese (Romy) during Storage. International Journal of Food Science and Nutrition Engineering 5(1): 15-23.

El-Neenay, M., S.A. Awad, M. Abbas and I.A. Attia. 2013. Production of Enzyme Modified Ras Cheese. Alex. Sci . Exch. J. 34: 249-254.

El-Sayed, S. M. 2020. Use of spinach powder as functional ingredient in the manufacture of UF-Soft cheese. *Heliyon*, 6(1), e03278.

El-Shibiny, S., M. A. Abd El-Gawad, F. M. Assem and S. M. El-Sayed. 2018. The use of nanosized eggshell powder for calcium fortification of cowon of cowl ingrs milk yogurts. *Acta Scientiarum Polonorum, Technologia Alimentaria. 17*(1), 37aria

Fathi, F. A. and N. M. A. Dabiza. 2005. Observation on the microstructure and texture of probiotic Ras cheese. Bulletin National Nutritional Institute.

Fields, R. 1971. The measurement of amino groups in proteins and peptides. Biochemical Journal, 124:581-590

Grand View Research. 2021. Dairy alternatives market share & growth Report, 2021–2028. https://www.Grandviewresearch.Com/Industry-Analysis/Dairy- Alternatives-Market. (Accessed 27 July 2021).

Hao, X., W. Yang, Q. Zhu, G. Zhang, X. Zhang, L. Liu, X. Li, M. A. Hussain, C. Ni, and X. Jiang. 2021. Proteolysis and ACE-inhibitory peptide profile of Cheddar cheese: Effect of digestion treatment and different probiotics. *LWT-Food Science and Technology*, *145*, 111295. https://doi.org/10.1016/j.lwt.2021.111295

Hans, P. B. 2001. Cheese analogues: a review. International Dairy Journal 11 (505–515).

Hofi, A. A., E. H. Yossef, M. A. Ghoneim, and G. A. Tawab. 1970. Ripening changes in Cephalotyre ‘‘Ras’’ cheese manufactured fromraw and pasteurized milk with special reference to flavour. Journalof Dairy Science, 53, 1207–1212.

John, S. M. and E. D. O'Riordan. 2008. Characteristics of imitation cheese containing native or modified rice starches. Journal of Food Hydrocolloids 22 (1160–1169).

Khaled, E. Z., M. Sabah, A. Tamara and A. Karim. 2015. Fundamental modeling, functional attributes, porosity, cohesivity index (Hausner ratio) and compressibility of expanded-granule powder of Egyptian Ras pure cheese. Journal of Food Science and Technology 64 (297-307).

Khorsandmanesh, S., M. Gharachorloo, M. Bahmaie, M. A. Zand and R. Azizinezhad. 2020. Sterol and Squalene as Indicators of Adulteration of Milk Fat with Palm Oil and Its Fractions. Journal Agriculture Science Technology Vol. 22(5): 1257-1266.

Kumar Gedela Santhosh, S. k M. Subhani and A. Bahurudeen. 2022. Sustainable reuse of palm oil fuel ash in concrete, alkali-activated binders, soil stabilisation, bricks and adsorbent: A waste to wealth approach. Industrial Crops & Products 183, 114954

Kiely, L. J., S. L. McConnell, and P. S. Kindstedt. 1991. Observations on the melting behaviour of imitation Mozzarella cheese. Journal of Dairy Science, 74, 3568–3572.

Kuchroo, C. N., J. Rahilly and P. F. Fox. 1983. Assessment of proteolysis in cheese by reaction with trinitrobenzene sulphonic acid. Irish Journal of Food Science and Technology 7 129-133

Lee, C. H., E. M. Imoto and C. Rha. 1978. Evaluation of cheese texture . Journal Food Science, 43: 1600.

McSweeney, P. L. H. 2004. Biochemistry of cheese ripening. International Journal of Dairy Technology, 57(2e3), 127e144. http://dx.doi.org/10.1111/j.1471-0307.2004.00147.x.

Mohamed, A. G. and S. M. Shalaby. 2016. Texture, chemical properties and sensory evaluation of a spreadable processed cheese analogue made with apricot pulp (*Prunus armeniaca L.*). *International Journal of Dairy Science*, *11*(2), 61–68. https://doi.org/10.3923/ijds.2016.61.68

Noor, L. H. M. D., A. H. Rafidah, K. Sivaruby, R. A. I. Wan, A. M. H. Norazura, H. I. Nur, O. Zaliha and M. S. Miskandar. 2017. Palm Oil and palm Kernel Oil: Versatile Ingredients for Food Applications. Journal of Oil Palm Research Vol. 29 (4) December 2017 p. 487 – 511. DOI: https://doi.org/10.21894/jopr.2017.00014.

Oyeyinka, A. T., J. O. Odukoya, and Y. S. Adebayo. 2019. Nutritional composition and consumer acceptability of cheese analogue from soy and cashew nut milk. *Journal of Food Processing and Preservation*, *43*(12), Article e14285. https://doi.org/10.1111/ jfpp.14285

Phelan, J. A., J. Renaud, and P. F. Fox. 1993. Some Non-European cheese varieties. In P. F. Fox (Ed.), Cheese: Chemistry, physics and microbiology (pp. 421-465). US: Springer.

Rahul Kamath, Somnath Basak, Jyoti Gokhale. 2022. Recent trends in the development of healthy and functional cheese analogues-a review. Food Science and Technology 155 (2022) 112991

SAS, Statistical analysis Institute. 2000. SAS User, s Guide, Version 4.02. SAS Inst., CARY, N.C.

Sumarmono, J., B. Sustriawan, N. Aini, V. Prihananto, and A. Widiastuti. 2021. The effect of addition of whey protein concentrate and emulsifier on characteristics of cheddar cheese analogue from corn milk. *IOP Conference Series: Earth and Environmental Science*, *653*(1), Article 012127.

Savijoki, K., H. Ingmer and P. Varmanen. 2006. Proteolytic Systems of Lactic Acid Bacteria. Applied Microbiology and Biotechnology, 71, 394-406. http;//dx.doi.org/10.1007/s00253-006-0427-1.

Shalaby A. R., M. M. Anwar, E. M. Sallam and W. H. Emam. 2016. Quality and safety of irradiated food regarding biogenic amines: Ras cheese. International Journal of Food Science and Technology 2016, 51, 1048–1054.

Sung, K. K. and H. D. Goff. 2010. Effect of solid fat content on structure in Ice creams containing palm kernel oil and High – Oleic Sunflower oil. Journal of food science, 73 (3), C274-9.

Taranto, M. V. and C. S. T. Yang. 1981. Morphological and textural characterisation of soybean Mozzarella cheese analogs. Scanning Electron Microscopy, 3, 483–492.

Wan, R. A. I. and A. I. Nor. 2000. Application of palm products in Ice cream. Palm Oil Development, 33 (8-12).

Wiącek, A.E. and E. Chibowski. 2005. Comparison of the Properties of Vegetable Oil/Water and n-Tetradecane/Water Emulsions Stabilized by a-Lactalbumin or b-Casein. Adsorption Science & Technology Vol. 23 No. 9 2005

الملخص العربي

إنتاج مشابه الجبن الراس بالإستبدال الجزئى أو الكلى لدهن اللبن بزيت النخيل

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كان الغرض من هذا البحث هو معرفة إمكانية إستخدام زيت النخيل كبديل طبيعي لدهن اللبن في تصنيع مشابه الجبن الراس ، وكذلك لمعرفة المزيد عن طلب العملاء والقبول الحسي لمشابهات الجبن الراس وكيف يمكن اكتشافها. تم دراسة استخدام زيت النخيل (PO) كبديل جزئي أو كلي لدهن اللبن في تصنيع مشابهات جبن الراس. حيث تم انتاج سبع معاملات عن طريق استبدال دهن اللبن جزئيًا أو كليًا بزيت النخيل. واجراء التقييم الحسي بعد ٣ أشهر. فأظهرت النتائج أن استبدال دهن اللبن بنسب مختلفة من زيت النخيل أدى إلى زيادة معنوية في المحتوى من الرطوبة، على الرغم من انخفاض المواد الصلبة الكلية ، مقارنة بالكنترول. مع تقدم فترة التخزين ، زادت نسبة المادة الصلبة (الدهون والبروتين الكلي والملح والرماد) وإزدادت قيمة الرقم الهيدروجيني بينما إنخفضت الحموضة بزيادة نسبة زيت النخيل. ايضا انخفض معدل الأحماض الدهنية الحرة ومستويات النيتروجين الذائب مع استبدال دهن اللبن بزيت النخيل. وخلال فترة التخزين التي بلغت ثلاثة أشهر، إزدادت صلابة المنتج وتماسكه وجهد المضغ. وانخفضت درجة قبول النكهة باستبدال دهن اللبن بزيت النخيل، لكن كان استبدال حتى ٢٪ دهن اللبن بزيت النخيل (T3) في لبن الجبن لم يؤثر معنويا على القبول العام للجبن مقارنة بالكنترول. لذا، فإن استبدال ما يصل إلى ٢٪ من دهن اللبن بـ PO لا يمكن اكتشافه من قبل المستهلكين ، وهذا يحتاج إلى مزيد من تركيز السلطات للكشف عن الجبن الراس المغشوش في الأسواق.

الكلمات المفتاحية: جبن الراس ، زيت النخيل ، تحليل القوام ، التقييم الحسي.