Quality and safety of processed cheese spread in relation to its dairy ingredients

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ABSTRACT

Four treatments of low fat spreadable processed cheese (SPC) according to the Ras cheese brand (RCB), from which SPC was made as follow: T1 (The control) was made using aflatoxin (AF)-free RCB, T2 was made using RCB containing 0.09 ppb AFM1 and T3 was made using RCB containing 0.05 ppb AFM1+ 0.01 ppb AFM1 was further added. The T4 was made using RCB containing the highest level of AFM1 0.11 ppb, providing the SMP used for all treatments being confirmed aflatoxin-free. All recipes of low fat SPC were composed from 27.19% Ras cheese and 11.17% skimmed milk powder, besides nondairy additives. There are significant differences among all spreadable processed cheese (SPC) treatments, but remaining in complete agreement with those conformed to the specifications stipulated in Egyptian standard for the low fat SPC. Neither yeasts and molds nor coliform were found in all final products. These are positive relationships between hardness and the dry matter content of SPC. The adhesiveness parameter exhibited a trending opposite to that of hardness criterion. The cohesiveness property seemed trending similar to that of adhesiveness. It could be noticed that, the SPC that possessed the lowest springiness value had the highest gumminess as well as chewiness values and *vice versa*. The SPC is becoming containing aflatoxin M1 as its Ras cheese contained with a level related proportionally with the quantity used for its recipe. It could be concluded that, no matter how great the hygienic and sanitation precautions are in the manufacture of processed cheese; this does not replace the need to investigate the quality, and rather the safety, of the raw materials involved in the industry.

Keywords: Ras cheese; skimmed milk powder; texture profile of spreadable processed cheese.

INTRODUCTION

Food safety concerns are constantly emerging in developed as well as in developing regions of the world. Among various animal sourced foods, dairy products are important components of our daily food basket and are being consumed by around 6 billion people across the globe, the majority being from developing countries (Quintana *et al.*, 2020). However, nowadays, milk is being contaminated by various pollutants primarily because of poor animal husbandry practices (Owusu-Kwarteng *et al.*, 2020).

Occurrence of aflatoxins in animal feed stuffs is primarily influenced by agro-climatic factors and storage conditions (Gruber-Dorninger *et al.*, 2019 and Mahato *et al.*, 2019).

Aflatoxins are considered as secondary metabolites of *Aspergillus flavus* and *A. parasiticus*, which are thought as one of the most dangerous mycotoxins (Mohamed, 2005 and Ehsani *et al.*, 2016). Among 18 different types of aflatoxins, such as, B1, B2, G1, G2, P, Q, M1 and M2 were identified . The most commonly occurring ones in fungi cultures are aflatoxins B1, B2, G1 and G2, then aflatoxins M1 and M2 in milk. Among the group AFB1 is listed as a Group 1 Carcinogen (IARC, 2016).

Dairy animals those are fed on aflatoxin (AF) B1- contaminated feedstuffs excrete its hydroxylated metabolite known as AFM1 into their milk (Prandini *et al.*, 2009). There are strong evidences that indicate linear relationship between them it's began in the 1960 s, with the first reported cases of contamination by AFM1, which is an AFB1metabolite produced in the animal rumen and secreted in milk.

Dairy products may contain aflatoxins due to two different sources: indirect contamination, which occurs when dairy cows consume aflatoxins in their feed that are then excreted in their milk, such as AFM1, and direct contamination, which occurs when mold accidentally grows and releases aflatoxins (Sengun *et al.*, 2008).

AFM1 has been categorized by the International Agency for Research on Cancer (IARC, 2002) as a group 1 human carcinogen. Dairy products may become contaminated with AFM1 at levels higher than those seen in the original milk because AFM1 is preferentially associated to the casein component of milk (Cavallarin *et al.*, 2014). Many nations have aflatoxins laws because the high occurrence of AFM1 in milk is a hazard for public health.

Due to the serious harm caused to human and animal health by aflatoxins, many countries and international organizations (e.g., the European Union and the Joint FAO/ WHO Expert Committee on Food Additives) have established relevant standards for limiting in order to safeguard consumer's health, maximum permissible limits (MPL) for the occurrence of AFM1 in milk and milk product have been established at 0.05 μg/L and 0.5 μg/L by the European Commission (EC) and the Food Safety and Standards Authority of India (FSSAI), respectively (EC 2006 and FSSAI 2011).

Processed cheese is a very important dairy product that is produced and handled easily without the need for special conditions because of its high conservation capacity; it also cast a very popular product, especially for children, owing to its likable savor and distinctive texture. In Egypt, the quantity of processed cheese locally produced is about 80,000 tons *per* year (CFI, 2023). It manufactured by blending natural cheese of different ages and degrees of maturity in the presence of emulsifying salts and other dairy, as source of active casein, and non-dairy ingredients followed by heating and continuous mixing to form a homogeneous product with an extended shelf life (Meyer, 1973; and Guinee *et al.,* 2004). Although the processed cheese is exposed during its manufacture to thermal processing, the final product may suffer from some healthy safety problems such as the incidence of aflatoxins. Therefore, the aim of this study was to find out to what extent the situation of raw materials as well as the thermal treatment can affect the quality and safety of the resulting processed cheese.

MATERIALS AND METHODS

Materials

Four samples of Ras cheese, 500 g for each and one kg sample of skimmed milk powder, were collected from different markets in different places during period expended from August to November 2022 as present in Table (1).

Egy phos S_2 emulsifying salts was obtained from the Egyptian company for dairy products and food additives "Egy dairy" Egypt. JOHA HBS Emulsifying salt with bacteriostatic effect for the manufacture of processed cheese and preparations was obtained from the local market.

Experimental procedures

Four treatments of low fat spreadable processed cheese (SPC) according to the Ras cheese brand (RCB), from which SPC was made as follow: T1 (The control) was made using mycotoxin-free RCB No.1, T2 was made using RCB No.2 (Containing 0.09 ppb M1), T3 was made using RCB No. 3 (Containing 0.05 ppb M1+ 0.01 ppb M1 was further added) and T4 was made using RCB No.5 (Containing the highest level of M1 0.11 ppb) providing that, the SMP used for all treatments was confirmed mycotoxin-free.

The procedure of low fat SPC was applied as described by Savello *et al.* (1989). All recipes of low fat SPC were composed from 27.19% Ras cheese, 11.17% aflatoxin-free SMP, 2.5% Egy Phos S_2, 0.5% JOHA HBS, 1.0% NaCl and 67.64% water. The blends were heated to 85°C, with continuous agitation for 5 – 10 min and kept at the same temperature for approximately 4 min, prior to filling into plastic packaging then leaving to cool and cold storing at 5-7°C.Three replicated were carried out for every treatment.

Analytical methods

The total solids and ash contents were determined as described in AOAC (2019). Total nitrogen content was determined by the Semi Micro Kjeldahl method as described in AOAC (2019).The conversion factor to protein was 6.38 as recommended by Renner (1983).The fat content was determined using Gerber tube as described by Ling (1963). Titratable acidity was determined as lactic acid according to Ling (1963).The NaCl content was determined as described by Marshall (1992).

A suitable modified QuEChERS method for the analysis of aflatoxins, B1, B2, G1, G2 and M1 in food samples was validated as in AOAC (2019) and European (EN 15662) QuEChERS method. Ultra High Performance Liquid Chromatography (UHPLC) Thermo Vanquish Coupled UHPLC with TSQALTIS Operated under System Equipped with a Fluorescence Detector (FLD), analytical Column C18 (100 X 2.1 Mm X 2.6μm) was used for measurement. The column and sample temperature were maintained at 40 and 20 °C. Detector was a fluorescence detector at (355nm excitation, 435nm emission). The system was computer controlled and EMPOWER3 software was used for the analysis of data.

The pH values were measured using a laboratory digital pH meter model Adwa 1030.

Spreadable processed cheese samples were subjected to texture profile analysis (TPA) using a Texture Analyzer (TMS-Pro, USA) according to Borne (2002).The samples were subjected to two successive compressions (bites) at 50% deformation using a cylindrical probe of 20 mm diameter and 35 mm length at three different locations for each yoghurt sample. The speed of the crosshead was kept at 1 mm/sec with a load cell of 25 N. Fracturability, Hardness I and Hardness 2, work carried out on the sample during the first bite (Al) and on the second bite (A2), cohesiveness (A2/A1), springiness (elasticity) and chewiness were obtained using soft were provided with the used of computerized texture analyzer as in Kumar and Mishra (2004).

The microbiological methods outlined in the standard methods for the examination of dairy products (Marshall, 1992) were applied for the determination of the following specific bacterial groups: Total bacterial count were enumerated using the pour plate method by using Trypticase Soya Agar (TSA), plates were incubated at 37°C for 48 h. Yeasts and molds counts (Y&M) were enumerated using the pour plate method by using Potato - dextrose agar (PDA), plates were incubated at 25°C for 5 day. Coliform bacterial count were enumerated using the pour plate method by using Violet Red Bile Agar (VRBA).plates were incubated at 37°C for 24 h.

The data obtained were exposed to proper statistical analysis according to statistical analyses system user's guide (SPSS, 1998).

RESULTS AND DISCUSSION

Compositional quality and safety of PCS dairy ingredients

Data of Table (2) indicated that, there are significant differences between brands in all parameters determined namely, dry matter, protein, fat, ash and salt/moisture content as well as pH value (p<0.001).

Compositionally, the dry matter (DM) contents of Ras cheese samples were fluctuated from 68.84 to 72.18 with an average of 70.00%. The protein contents were ranged from 31.15 to 33.30 with a mean of 32.26%. The fat/DM% was ranged from 47.21 to 49.46 with an average of 48.48%. The ash contents were fluctuated from 8.49 to 9.77 with a mean of 9.08%. These compositional qualities are in coincidence with the Egyptian standard limits of Ras cheese given in EOSQ (2005). The salt/moisture % was ranged from 11.81 to 12.67 with an average of 12.14%. While pH values of Ras cheese samples were ranged from 5.28 to 5.84. In details, sample coded with the No. (3) possessed significantly the highest dry matter content and hence the highest protein, fat and as well as the salt/moisture contents versus the other samples (Table, 2). The Ras cheese samples coded with the number (2) became in the second order towards the dry matter, protein and fat contents. While the sample No. (4) gained the second order in the ash content, while the samples No. (1) exhibited the second order in the salt/moisture content (Table, 5). The obtained results are in coincidence with those of Mohamed (2005), who reported that, the DM and fat/DM contents of all samples were conformed to the Egyptian legal standard and did not differ among the four surveying locations. Likewise, the protein content of all samples was confirmed to the Egyptian legal standard.

Regarding the pH value, Ras cheese samples No. (4) had the highest value followed by that as No. (1), nevertheless, there were no significant differences among the pH values of Ras cheese samples No. (2) and (3).

The obtained composition of skimmed milk powder (SMP, Table, 2) was in complete agreement with those previously found by Mahran *et al*. (1993) as well as they are in accordance with the legal standard of EOSQ (2017).

As could be seen in Table (3), the total bacteria log counts of Ras cheese were ranged from 10.22 to 11.59. The log counts of yeasts and molds were fluctuated from 2.19 to 3.42. The coliform log counts were ranged from 0.70 to 1.68. It is worthy to mention that the count allowed by the Egyptian specifications of EOSQ (2005) for Ras cheese does not exceed 10 colony forming unit (cfu) of coliform / g, 10 cfu of fungi/g and 100 cfu of yeasts / g. In details, sample coded with No. (1) contained the highest total bacterial log count followed by those of sample No (2) or (4). While the sample No (3) had the lowest log total bacterial count. These phenomena led to confirm that, these are relatively negative relationships between the dry matter content and microbial load of Ras cheese (Tables, 2 and 3).

Moreover, both log count either of yeasts and molds or coliform behaved the same trending among all five samples of Ras cheese, stating that the conditions offered for yeasts and molds to grow are nearly the same preferred for coliform Table (3).

Mohamed (2005) found that, the yeasts and molds count of surveyed Ras cheese as a microbial quality indicators confirmed the unsafety of all samples for the human consumption according to the Egyptian legal standard. The count reached to $3x10^2$-$9xl0^4$ without any significant differences between them.

As demonstrated from the data given in Table (4), without any expectation, all Ras cheese samples were free from the aflatoxins of B1, B2, G1 and G2. Nevertheless all cheese samples except of No (1) contained aflatoxin (AF) M1 at different levels fluctuated from 0.04 to 0.11 ppb. These could indicate that, such cheeses had been made from milk obtained from animals fed previously on diets contaminated with mycotoxins. Trucksess and Diaz-Amigo (2011) reported that, AFM1 is produced in the liver of animals following ingestion of high levels of AFB1, and it may be excreted in the milk and urine of animals.

The incidence of aflatoxins, especially AFM1, in hard cheese and rather Ras cheese was detected and confirmed by many researchers. Two of 10 hard cheese samples contained detectable levels of AFM1 (3and 6 ppb) (El-Sayed *et al.,* 2000). 1.9 and 1.98 ppb of AFM1 was detected in aged Romi cheese and fresh Romi cheese, respectively by Motawee *et al.* (2004). AFM1 was detected in 56 % of examined Ras cheese samples with levels ranging from 7.40 to 111.50 ng/kg by Aiad and Abo El-Makarem (2013), who reported that, most of positive samples are exceeding Egyptian regulations (1990), the European Commission Regulation and Codex Alimentarius Commission (2001). They concluded that widespread occurrence of AFM1 in some dairy products samples was considered to be possible hazards for public health, especially children. In another study carried out by Esam *et al.* (2022), AFM1 was found in all investigated Ras cheese with mean value of 51.05±6.19 ng/kg. Moreover, there was statistically no significant difference between AFM1 levels in the core and crust parts of the tested Ras cheese. AFM1 contaminated Ras cheese samples was 48.57% which exceeded the European and Egyptian tolerance levels.

The SMP sample was totally free from all aflatoxins (Table, 4).

Physiochemical properties of processed cheese spread

The results of Table (5) showed that, there are significant differences among all spread able processed cheese (SPC) treatments, where the DM contents of processed cheese spread were fluctuated from 33.94 to 34.75 with an average of 34.26%. The protein contents were ranged from 11.88 to 12.40 with a mean of 12.13%. The fat contents were ranged from 8.90 to 9.8 with a mean of 9.30%. The ash contents were fluctuated from 7.13 to 7.22 with an average of 7.19%. The NaCl % was ranged from 2.19 to 2.62 with a mean of 2.48%. In details, the treatment No.3 exhibited the highest dry matter, protein, fat and ash contents in comparison with the other three samples inclusive the control (treatment No.1). Generally all obtained results are in complete agreement with those conformed to the specifications stipulated in EOSQ (2013) for the low fat spreadable processed cheese.

Regarding the ash as well as salt contents both of them took trending similar to the other. Where, the processed cheese spread that possessed the highest salt level contained at the same time the highest ash content and *vice versa*. That could be due to the variations in the salt content of starting Ras cheese used in recipe of processed cheese, especially since the adding levels of emulsifying salt and NaCl were constants.

With regard to the pH value of the resultant processed cheese spread, it was fluctuated from 5.40 to 5.86 indicating that it located in the range designated for spreadable processed cheese as described by Meyer (1973).

Similar observations were reported by Mahran *et al.* (2007), Negm (2007) and Fayed *et al.* (2009).

Microbiological quality of processed cheese spread

The log counts of total bacteria of SPC were fluctuated from 2.70 to 5.11with an average of 4.44 log cfu / g. The highest total bacterial log count was enumerated in the processed cheese spread treatment No.4 followed by treatment No.2. While the treatment No.3 appeared the lowest log count of total bacteria (Table, 6).

Moreover, it worthy to mention that, due to the high sanitation precautions adapted along all manufacture steps of proceeds cheese spread, neither yeasts and Molds nor coliform were found in all final products (Table, 6).

Texture profile of spreadable processed cheese

Hardness is the force required to compress a sample between the molars as explained by Szczesniak *et al.* (1963) and Bourne (2002).

Concerning the hardness criterion of SPC (Table, 7), its values were ranged from 7.89 to 12.93 with a mean of 10.25 N. The treatment No.3 was characterized with the highest value followed by No.2, 1 and the treatment No.4 became in the last order. It could be noticed that these are positive relationships between this criterion and the dry matter content of the treatment.

On the contrary, the adhesiveness parameter exhibited a trending opposite to that of hardness criterion, where its values ranged 0.11-0.89 and achieved an average of 0.49 mJ. While, the cohesiveness property recorded a range of 0.25-0.48 and an average of 0.34. Moreover, it behaved similar behaviour to the latter. Cohesiveness is a measure for the structure stability of a food specimen and if it withstands repeated compression or not. Cohesiveness is the strength of internal bonds making up the body of the product as explained by Szczesniak *et al.* (1963) and Bourne (2002). It is a parameter for measuring the ability of product to adhere with each other. Similar findings were reported by Fayed *et al.* (2013), Salama *et al.* (2022) and Salama (2023).

Furthermore, the springiness values were fluctuated from 1.70 to 2.76 with a mean of 2.16 mm (Table, 7). It could be noticed that, the processed cheese spread that possessed the lowest springiness value had the highest gumminess as well as chewiness values and *vice versa*. Gumminess values were ranged from 2.57 to 6.20 and averaged 3.57 N. Chewiness values were fluctuated from 4.93 to 10.52 and ranged 7.27 mJ. Szczesniak *et al.* (1963) and Bourne (2002) explained that, **s**pringiness is the rate at which a deformed material returns to its original shape on removal of the deforming force, *i.e.* springiness is a textural parameter expressing the degree of ability of a product to springs back after it had been deformed during the first compression.

Aflatoxins incidence of spreadable processed cheese

The results of Table (8) are obviously indicating that, the processed cheese spread is becoming containing aflatoxin as its Ras cheese contained with a level related proportionally with the quantity used for its recipe, where, except of the control, the resultant processed cheese spread contaminated with AFM1 levels ranged 0.02 to 0.03 with an average of 0.025 ppb. That means the heat treatment applied in the manufacture of processed cheese did not contribute to the reduction in the aflatoxins load.

Galvano *et al.* (1996) reported that, aflatoxins are relatively heat stable compounds and not completely degraded when treated with high temperature like boiling, autoclaving, pasteurization, sterilization, spray drying, and other processing using methods used to food preparation. Moreover, Yazdanpanah *et al.* (2005) suggested that, the heat stability of aflatoxin is affected by some factors; such as pH and moisture content.

Carvajal *et al.* (2003) reported the presence of AFB1 (0 to 0.4µg/L) in heat-treated milk samples. However Raters and Matissek (2008) stated AFB1 to be almost completely degraded at heating temperatures of 160 °C and above. Furthermore, Awasthi *et al.* (2012) reported that, neither pasteurization nor boiling processes affected the level of AFM1 in bovine milk**.**

CONCLUSION

Finally, it could be concluded that, no matter how great the hygienic and sanitation precautions are in the manufacture of processed cheese; this does not replace the need to investigate the quality, and rather the safety, of the raw materials involved in the industry.

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AOAC, 2019: The conversion factor was 6.38. (n) Ash content: The ash content was determined according to the method by AOAC, (2019).

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Table 1: Label data of Ras cheese and skimmed milk powder samples surveyed from the local market

Product kind	Origin	Manufacturing Date	Code
Ras cheese	Kalubia	Feb/2022	1
Ras cheese	Damietta	Jun/2022	2
Ras cheese	Kalubia	Oct/2021	3
Ras cheese	Elbehira	May/2022	4
Skimmed milk powder	France	Sept/2002	-

Table 2: Physiochemical properties of surveyed Ras cheese and skimmed milk powder samples as given in Table (1)

Property	Sample code				Skimmed milk powder
	1	2	3	4	
Dry matter (DM) %	69.62^{c}	70.24^{b}	72.18^{a}	68.84^{e}	96.33
Protein (TN x 6.38%)	31.81^{d}	32.74^{b}	33.30^{a}	32.30^{c}	33.95
Fat%	34.00^{b}	33.70^{b}	35.70^{a}	32.50^{c}	-
Fat / DM %	48.84	47.55	49.46	47.21	-
Ash%	9.10^{c}	8.75^{d}	9.77^{a}	9.31^{b}	6.48
Salt / Moisture %	12.34^{b}	12.09^{c}	12.67^{a}	11.81^{d}	-
pH value	5.46^{b}	5.28^{c}	5.31^{c}	5.84^{a}	6.55

TN :Total Nitrogen

Table 3: Microbiological quality (log cfu /g) of surveyed Ras cheese samples

Kind of microbe	Sample code			
	1	2	3	4
Total bacteria	11.59^{a}	10.56^{b}	10.22^{d}	11.09^{b}
Yeasts & molds	2.19^{e}	3.42^{a}	2.66^{d}	3.02^{c}
Coliform	1.68^{e}	1.09^{a}	0.70^{d}	1.55^{c}

cfu: colony forming unit

Table 4: Aflatoxins incidence (ppb) of surveyed Ras cheese and skimmed milk powder samples as given in Table (1)

Kind of aflatoxin	Sample code				Skimmed milk powder
	1	2	3	4	
B1	ND	ND	ND	ND	ND
B2	ND	ND	ND	ND	ND
G1	ND	ND	ND	ND	ND
G2	ND	ND	ND	ND	ND
M1	ND	0.09	0.05	0.11	ND

ND: Not detected.

Table 5: Chemical and physical properties of spreadable processed cheese.

Property	Treatment No			
	1	2	3	4
Dry matter %	34.11^{b}	34.24^{b}	34.75^{a}	33.94^{d}
Protein (TN x 6. 38)%	11.88^{d}	12.19^{b}	12.40^{a}	12.05^{c}
Fat%	9.30^{b}	9.20^{c}	9.80^{a}	8.90^{d}
Ash%	7.22^{a}	7.13^{b}	7.19^{a}	7.20^{a}
Salt%	2.62^{a}	2.49^{b}	2.19^{c}	2.62^{a}
pH value	5.4^{c}	5.58^{b}	$5. 64^{d}$	5.86^{a}

TN :Total nitrogen

T1 (The control): made using aflatoxin-free Ras cheese brand (RCB) No.1.

T2: made using RCB No.2 (Containing 0.09 ppb M1).

T3: made using RCB No. 3 (Containing 0.05 ppb M1+ 0.01 ppb M1 was further added).

T4: made using RCB No.4 (Containing the highest level of M1 0.11 ppb).

Table 6: Microbiological quality (log count / g) of spreadable processed cheese

Kind of microbe	Treatment No			
	1	2	3	4
Total bacterial count	4.90[c]	5.04[b]	2.70[d]	5.11[a]
Yeast &Molds	ND	ND	ND	ND
Coliform	ND	ND	ND	ND

ND: Not detected

T1 (The control): made using aflatoxin-free Ras cheese brand (RCB) No.1.

T2: made using RCB No.2 (Containing 0.09 ppb M1).

T3: made using RCB No. 3 (Containing 0.05 ppb M1+ 0.01 ppb M1 was further added).

T4: made using RCB No.4 (Containing the highest level of M1 0.11 ppb).

Table 7: Texture profile of spreadable processed cheese

Parameter	Treatment No.			
	1	2	3	4
Hardness (N)	9.14[c]	11.05[b]	12.93[a]	7.89[d]
Adhesiveness (mJ)	0.89[a]	0.69[b]	0.11[d]	0.26[c]
Cohesiveness (Ratio)	0.28[c]	0.25[c]	0.48[a]	0.34[b]
Springiness (mm)	2.76[a]	2.36[b]	1.70[d]	1.83[c]
Gumminess (N)	2.57[d]	2.78[b]	6.20[a]	2.73[c]
Chewiness (mJ)	7.05[b]	6.57[c]	10.52[a]	4.93[d]

T1 (The control): made using aflatoxin-free Ras cheese brand (RCB) No.1.

T2: made using RCB No.2 (Containing 0.09 ppb M1).

T3: made using RCB No. 3 (Containing 0.05 ppb M1+ 0.01 ppb M1 was further added).

T4: made using RCB No.4 (Containing the highest level of M1 0.11 ppb).

Table 8: Aflatoxins load (ppb) of spreadable processed cheese

Kind of aflatoxin	Treatment No			
	1	2	3	4
B1	ND	ND	ND	ND
B2	ND	ND	ND	ND
G1	ND	ND	ND	ND
G2	ND	ND	ND	ND
M1	ND	0.02	0.02	0.03

T1 (The control): made using aflatoxin-free Ras cheese brand (RCB) No.1.

T2: made using RCB No.2 (Containing 0.09 ppb M1).

T3: made using RCB No. 3 (Containing 0.05 ppb M1+ 0.01 ppb M1 was further added).

T4: made using RCB No.4 (Containing the highest level of M1 0.11 ppb).

جودة وسلامة الجبن المطبوخ وعلاقته بخاماته اللبنية

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الملخص العربي

أربعة معاملات لمعجون الجبن المطبوخ منخفض الدهن وفقا للعلامة التجارية للجبن الراس على النحو التالي: المعاملة الاولى T1 (الكنترول) تم إنتاجها باستخدام جبن راس خالي من السموم الفطرية. المعاملة الثانية T2 تم تصنيع معجون الجبن المطبوخ باستخدام عينه الجبن الراس التي تحتوي على الأفلاتوكسين M1 بتركيز0.09 جزء فى البليون .المعاملة الثالثة T3 تم تصنيع معجون الجبن المطبوخ باستخدام عينه الجبن الراس التي تحتوي على الأفلاتوكسين M1 بتركيز0.05 جزء فى البليون + 0.01 جزء فى البليون تمت إضافتها. المعاملة الرابعة T4 تم تصنيع معجون الجبن المطبوخ باستخدام عينة الجبن الراس التي تحتوي على أعلى مستوى من الأفلاتوكسين (M1 0.11 جزء فى البليون). شريطة أن اللبن الفرز المجفف المستخدم في جميع المعاملات خالى من السموم الفطرية.كانت جميع وصفات معجون الجبن المطبوخ منخفض الدهن تتكون من 27.19٪ جبن رأس و 11.17٪ لبن فرز مجفف ، إلى جانب المواد المضافة الغير اللبنيه. هناك اختلافات كبيرة بين جميع معاملات معجون الجبن المطبوخ ولكنها تظل متفقة مع المعايير المنصوص عليها في المواصفات القياسية المصرية الخاصة بمعجون الجبن المطبوخ منخفض الدهن. لم يتم العثور على الخمائر والفطريات وكذلك بكتريا االقولون في جميع عينات الجبن المطبوخ النهائية. هناك علاقه إيجابية بين معامل hardness ومحتوى المادة الجافة في معجون الجبن المطبوخ. أظهر معامل الالتصاق adhesiveness اتجاهاً معاكساً لخاصية hardness ، بدت خاصية cohesiveness شبيه ب معامل الالتصاق adhesiveness. ويمكن ملاحظة أن معجو ن الجبن المطبوخ القابل للفرد الذي يمتلك أقل قيمة springiness كان لديه أعلى قيم للتصمغ gumminess وللقابلية للمضغ chewiness والعكس صحيح. معجون الجبن المطبوخ يحتوي على الأفلاتوكسين M1 بمستوى متناسب مع كمية الجبن الراس المستخدمة في وصفته . *ويمكن استنتاج أنه مهما كانت الاحتياطات الصحية والصحية كبيرة في صناعة الجبن المجهز ؛ وهذا لا يحل محل الحاجة إلى التحقيق في نوعية المواد الخام المستخدمة في الصناعة، بل في أمانها.*

الكلمات الاسترشادية: جبن الراس, اللبن الفرز المجفف ,معجون الجبن المطبوخ.