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EFFECT OF GAMMA IRRADIATION ON THE QUALITY OF KAREISH CHEESE

(With 7 Tables)

By

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تأثير الأشعاع باستخدام أشعة جاما على جودة الجبن القريش

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يهدف البحث إلى دراسة تأثير الأشعاع باستخدام اشعة جاما على جودة الجبن القريش. وقد عوملت الجبن القريش بجرعات مختلفة من اشعة جاما وقدرها ١ و ٣ و ٥ كيلوجراى لتحديد مدى تاثيرها على الخواص الحسية والكيماوية والميكروبيولوجية للجبن القريش قبل وبعد التعرض للأشعاع. وقد حدث نقص فى كلا من الرطوبة والملح والنيتروجين المذاب والنيتروجين الكلى وبينما ارتفعت نسبة pH بشكل غير محسوس فى الجبن المشعع مقارنة بالجبن غير المشعع. كما تشير النتائج الى حدوث انخفاض بدرجة محسوسة للعدد الكلى للميكروبات وكلا من الفطريات والخمائر وبكتريا القولون وبكتريا الأمعاء وكذلك بكتريا العنقود الذهبى ويزداد التاثير بزيادة الجرعة عند ٥ كيوجراي. وقد خلصت النتائج الى ان زيادة الجرعة حتى ٥ كيلو جراى تزيد نسبة النقص العددى للميكروبات دون ادنى تاثير على الخواص الحسية والكيميائية للجبن القريش. ولهذا ينصح القائمين على صناعة الجبن القريش باستخدام ٥ كيلوجراى من اشعة جاما لتحسين جودة وسلامة المنتج.

SUMMARY

The effect of gamma irradiation on the quality of kareish cheese was evaluated. Egyptian kareish cheese were subjected to gamma irradiation at different safety doses beginning from 1 kilo gray (KGy) to a maximum of 5 KGy. The physico-chemical composition as well as microbiological quality of kareish cheese samples were monitored before and after irradiation. Moisture, salt, soluble nitrogen and total nitrogen decreased while pH was higher in cheese samples before irradiation in comparison with the irradiated groups. Irradiation reduced population of bacteria i.e. total colony count, total yeast and mold count, coliform count, total *Enterobacteriacae* count and total *Staphylococcus* count. The effect was more pronounced at the highest dose (5 KGy). It could be concluded that increasing the dose of irradiation up to 5 KGy had high reduction percentages for bacterial counts with no effects on either sensory or chemical characteristics. Our results suggest that kareish cheese manufacturers could use gamma irradiation to improve the safety of this product.

Key words: *Kareish cheese, gamma irradiation, quality*

INTRODUCTION

Kareish cheese is one of the most popular local type of fresh soft cheese in Egyptian countries. The increasing demand for it by Egyptian consumers is mainly attributed to its high protein content and low price. The traditional method for kareish cheese production affords many opportunities for microbial contamination. It is generally made from raw skim buffaloes or cows milk which is often of poor bacteriological quality owing to the high microbial load present in raw milk and the unsatisfactory conditions under which it is produced. Also, this product is sold uncovered and without container where the risk of contamination is high. Therefore it can be considered as a good medium for the growth of different types of spoilage and pathogenic microorganisms (Yousef, 2004 and Dawood, *et al.*, 2006).

Food irradiation is a preservation process exposing food to high energy rays to improve product safety and shelf life. It could be used to replace chemical preservatives as well as thermal treatment. It is considered as cold pasteurization of food and currently permitted in 35 countries world wide for 40 different food products (Robert, 1998; Thayer, 2005; Loaharanu, 2005). The use of gamma irradiation in dairy product is considered as one of the most important peaceful application of nuclear energy (FDA, 1997; WHO, 2005). There was no hazard caused by irradiation up to 10 kilo grey which could not cause cancer, genetic mutation or tumors (Mason, 1993; Ordonez *et al.*, 1999; Sofos, 2002; Mehran *et al.,* 2005; Steel, 2006). Therefore, hospitals use irradiated food for patients with severely impaired immune system (Lee, 1994; FAO, 1998; Leuschner and Boughtflower, 2002; Bernnand, 2006).

In Egypt, the information about the involvement of kareish cheese in human illness and economic losses are unknown. Therefore, this investigation was aimed to study the effect of gamma irradiation on organoleptic, physicochemical and microbiological quality of commercial kareish cheese samples.

MATERIALS and METHODS

Fourty random samples of kareish cheese were collected from dairy shops in Giza Governorates in sterile plastic bags and transferred directly to an insulated ice box. The kareash cheese samples (600 g) were divided into four parts (200g each). The first part unirradiated and used as a control. The second part (group I) was subjected to irradiation with one Kilo grey (KGy). The second part (group II) was irradiated with dose 3 KGy. The third part (group III) was irradiated with dose 5 KGy. The samples were subjected to gamma irradiation at 19°C ± 1°C with a dose rate of 0.105 KGy / min from A Cobalt 60 source at National Research for Radiation and Technology at Nasr City, Cairo, Egypt. The facility used was Gamma Chamber 400 (A Cobalt 60, Facility of India). The mean deviation of the absorbed dose from the target dose was 0.048 KGy with a standard error of 0.005 KGy. All cheese samples were examined immediately before and after irradiation for:

- Organoleptic examination

The kareish cheese samples were organoleptically scored using score card for flavor (50 points), body and texture (35 points) and appearance & color 15 points). The scores were averaged by five panelists according to Nelson and Trout (1981).

- Chemical analysis

All kareash cheese samples were chemically examined for pH using pH meter (model SA 720), moisture and salt content according to AOAC, (1998). Total nitrogen (T.N.) % and water soluble nitrogen content (S.N.) were determined using microkjeldhal method according to Kuchroo and Fox (1982) & IDF (1993).

- Microbiological examination

The cheese samples were prepared for microbiological examination according to ICMSF (1996). All samples were examined for total colony count (TCC); total mold and yeast count; coliform (MPN) count; total *Enterobacteriacae* count and total *Staphylococcus* count/g, according to APHA (1993).

- Statistical analysis

The logarithmic transformation of bacterial count and their analysis were done with the aid Microsoft Excel 2000 and Statistica 5, Version 97 software. All results were calculated as means and were subjected to statistical analysis according to the procedures reported by

Steel and Torrie (1982). The reduction % was calculated as follows: Logarithmic number in the irradiated cheese/ Logarithmic of the control cheese multiplied by 100.

RESULTS

Table 1: Organoleptic examination of kareish cheese samples.

Cheese Samples	Organoleptic scores			
	Flavor (50)	Body& Texture (35)	Appearance & Color (15)	Total scores (100)
Control	49±0.01	34±0.08	15±0.0.06	98
Group I	48±0.3	34±0.06	15±0.0.02	97
Group II	47±0.02	34±0.01	14±0.03	95
Group III	47±0.01	34±0.04	14±0.05	95

*There was no significant difference between the control and irradiated groups (P> 0.05).

Table 2: The mean chemical composition of kareish cheese samples

Cheese samples	Moisture%	Salt%	SN/TN%	pH	TN%
Control	65.2 ±0.9	1.28±0.03	9.05±0.1	4.16±0.8	2.58±0.02
I	64.0±0.5	1.25±0.1	8.62±0.4	4.30±0.12	2.67±0.05
II	62.8±0.03	1.26±0.5	8.25±0.3	4.37±0.05	2.66±0.05
III	60.0±0.08	1.27±0.03	8.02±0.7	4.50±0.01	2.59±0.01

*TN= Total nitrogen%

**S.N. / T.N. = soluble nitrogen/total nitrogen%

***There was no significant difference between the control and irradiated groups (P> 0.05).

Table 3: The mean total colony count (cfu/g) of kareish cheese

Cheese samples	Mean log.	Reduction%
Control	$6.27^{a} \pm 2.02$	0
I	$4.47^{a} \pm 1.9$	28.70
II	$3.70^{b} \pm 1.1$	40.98
III	$1.69^{b} \pm 0.1$	73.04

Mean Log. = Mean Logarithmic cfu/gm

Superscript ^{a} and ^{b} considered significantly different at P< 0.05

Table 4: Mean total mold and yeast count of kareish cheese.

Cheese samples	Mean Log.	Reduction%
Control	$7.89^{a} \pm 1.1$	0
I	$5.91^{a} \pm 1.4$	25.09
II	$3.62^{b} \pm 1.7$	66.79
III	$1.00^{b} \pm 0.31$	87.32

Superscript ^{a} and ^{b} considered significantly different at P< 0.05

Table 5: Total *Enterobacteriacae* count of kareish cheese samples

Cheese samples	Mean Log	Reduction%
Control	$4.80^{a} \pm 1.5$	0
I	$3.59^{a} \pm 1.1$	25.21
II	$1.69^{b} \pm 0.99$	64.79
III	<Less than log1 ^{b}	100

Superscript ^{a} and ^{b} considered significantly different at $P< 0.05$

Table 6: The mean total coliform count (MPN/g) of kareish cheese

Cheese samples	Mean Log.	Reduction%
Control	$5.54^{a} \pm 1.1$	0
I	$3.83^{a} \pm 1.2$	30.86
II	$1.47^{b} \pm 0.55$	73.46
III	< Less than log 1 ^{b}	100

*NA = not available

Superscript ^{a} and ^{b} considered significantly different at $P< 0.05$

Table 7: Total *Staphylococcus* count (cfu/g) of kareish cheese.

Group	Mean Log.	Reduction%
Control	$3.60^{a} \pm 1.6$	0
I	$2.80^{a} \pm 0.99$	22.22
II	$1.00^{b} \pm 0.5$	72.22
III	Less than log 1 ^{b}	100

Superscript ^{a} and ^{b} considered significantly different at $P< 0.05$

DISCUSSION

Sensory examination

Data illustrated in Table (1) showed the total score of control kareish cheese in comparison with irradiated cheese groups. Testing of irradiated kareish cheese samples revealed no significant difference ($P> 0.05$) between control and irradiated cheese (I, II and III) groups. Nearly similar findings were reported by (El -Batawy, 1999; Yousef *et al.,* 2001; Hamam, 2005) who stated that irradiation is known as cold pasteurization and does not significantly increase in temperature or change in the physical condition of food. The flavour of control cheese had the highest total score compared to irradiated cheese groups respectively. This may be due to the natural flora initially present in raw milk which participate in flavour production (Urbach, 1993; Henkel, 1998; Cambell-Platt, 1999).

Chemical analysis

Nutrition is an important issue to consumers. The effect of irradiation on the most important parameters in kareish cheese was recorded in Table 2. The control cheese samples had a mean moisture content of 65.2 ± 0.9 while the irradiated cheese samples had 64.0 ± 0.5; 62.8 ± 0.03 and 60.0± 0.08 respectively. There was no significant difference between the control and irradiated groups (P> 0.05). The moisture content of irradiated cheese samples was lower than control samples. This may be attributed to the effect of irradiation on the capacity of cheese protein on holding water (Kanka *et al.*, 1989; Schaffer *et al.*, 1995; El-Batawy, 1999). Nearly similar findings were reported by Abd El-Salam *et al.* (1992) and Ghosh *et al.* (1999). There was no significant difference (P> 0.05) between pH in control and irradiated cheese samples. Nearly similar findings were obtained by Abd El-Salam *et al.* (1992); Marth and Steele (2001); Lalaguna, (2003); Omer and Elshirbiny (2005). Irradiated cheese samples showed the lowest total nitrogen % (T.N.%) while the highest value of S.N./T.N. % was recorded with the control cheese. This may be due to the destructive effect of irradiation on the natural flora and milk enzymes which in turn affect protein (Ghosh *et al.*, 1999; Omer and Elshirbiny 2005). There was no significant difference between salt content in control and irradiated cheese samples.

Microbial profile

The effect of irradiation on total colony count was presented in Table (3). The total colony count estimates the total microbial load without specifying the type of germ. It reflects the hygienic level of the untreated (control) cheese samples. The reduction percent in the total colony count of group I, II and III were 28.70, 40.98 and 73.04 % in the irradiated cheese samples, respectively. The presented data indicate that low level of irradiation up to 1 kgy substantially diminished the number of total colony count. For the dose of 3 and 5 kgy, the microbial destruction was significantly higher (P< 0.05) than the control samples. Nearly similar findings were reported by El-Batawy (1999) and Yousef *et al.* (2001). The count in all irradiated groups decreased with increase the dose of irradiation. This was probably due to the effect of energy produced from irradiation which breaks the bonds in the DNA molecules, leading to inability of microorganisms to replicate and reproduce resulting in bacterial death (Gillard *et al.*, 2007). Some bacteria can repair the damage of DNA strands and resist the effect of irradiation. The effectiveness of the process depends on the organism's sensitivity to irradiation, the rate at which it can repair damaged DNA, and especially on the amount of DNA in the target organism. Also it depends on pH, temperature, water activity content (A_w), and the nature of the radiation used in the process (Molins and Ricardo, 2001). The obtained results declared that irradiation did not sterilize kareish cheese samples but it may prolong shelf life time by reducing growth of spoilage bacteria. The control kareish cheese samples had high total colony counts in relation to the Egyptian standards which should not exceed 10^2cfu/g with their freedom from all pathogenic microorganisms (EOSQC, 2005). Thus control kareish cheese is more likely to serve as a vector for food borne illness.

The total mold and yeast counts were significantly ($P<0.05$) higher in control cheese group in comparison with II and III irradiated groups (Table 4). The reduction percent in the total mold and yeast count were 25.09, 66.79 and 87.32% in the examined irradiated group I, II and III, respectively. There was significant difference ($P<0.05$) in control cheese samples in comparison with irradiated group II and III. Nearly similar findings were reported by Hamed *et al.* (1992) and Rehman *et al.* (2000). Irradiation at doses up to 5 Kg did not eliminate the mold and yeast population but reduce their growth by inhibiting their sprouting and maturation (Radomeski *et al.*, 1994; Lucht *et al.*, 1998). Yeast and mould in cheese are considered as spoilage organisms resulting in flavour and textural deterioration including softening, discoloration and slime formation (Besancon *et al.*, 1992). Not only molds and yeast deteriorate cheese but they also have pathogenic, allergic and toxic action. A large number of molds including mycotoxigenic fungi which produce mycotoxins are wide spread to contaminate kareish cheese rendering it unpalatable and unsafe for consumption (Law, 1999). As the Egyptian standard for mold and yeast count in kareish cheese should not exceed 10^2 cfu/g, control kareish cheese is more likely to serve as a vector for food borne illness (EOSQC, 2005).

The reduction percentage of *Enterobacteriacae* count were 25.21, 64.79 and 100% in the examined irradiated group I, II and III, respectively (Table 5). Increasing the dose of irradiation induced greater reduction in count of indicator organisms (*Enterobacteriacae*). At dose 5 kGy there was complete reduction in *Enterobacteriacae* count. Nearly similar findings were reported by Kroll (1995); Beresford *et al.* (1998); Moatsou *et al.* (2001). *Enterobacteriacae* are germs indicative of faecal pollution. In Europe they are an index widely used in cheese to appraise their hygienic quality. The result obtained would cofirm that 5 kGy dose of irradiation leads to optimum sanitation, not forgetting that the destruction of *Enterobacteriacae* would ensure the absence of other pathogenic gram negative bacteria. We, therefore think that a dose of 5 kGy is optimum.

Although coliforms are subgroup of *Enterobacteriacae* but we have studied their destruction as independent group. From the data summarized in Table (6) it could be seen that the reduction percent of *Coliform* counts were 30.86, 73.46 and 100% for group I, II and III, respectively. The coliforms count was markedly decreased with irradiation and completely disappeared in irradiated cheese group III. There was a significant difference ($P<0.05$) in control cheese samples in comparison with irradiated group II and III, respectively. At 5 kGy there was complete destruction of coliforms in the irradiated III cheese samples. Nearly similar findings were reported by El-Sissi and Neamat Allah (1996) and Leuschner and Boughflower (2002).

As shown in Table (7), gradual decrease in *Staphylococcus* count in all irradiated cheese samples. Irradiated cheese group III contained no colony count. The result indicate that a dose of 5 kGy could eliminate 100% of the *Staphylococcus* count present in cheese samples. Irradiation at 5 kGy is demonstrated to be suitable for inactivating food borne microorganisms in cheese. Nearly similar findings were reported by Kanka *et al.* (1989); Hamed *et al.* (1992); Monk *et al.* (1995); Ordonez *et al.* (1999). The growth of *Staphylococcus* in control kareish cheese may produce enterotoxins which causes food borne illness. So control cheese may harbour public health hazard for consumers than irradiated cheese samples (Rashed *et al.*, 1992; Zottola and Smith, 1993; Bastian *et al.*, 1993; Lee, 1994; Kroll 1995; Lamb *et al.*, 2002).

In conclusion, irradiated cheese has high quality and safety, free from pathogenic microorganisms with better flavour. The only disadvantage is the increase in cost. The advantages of irradiated cheese are strongly outweighing the disadvantages. Therefore, in kareish cheese factories where hundreds of thousands of liters of milk may be processed in a single day, it is imperative to irradiate kareish cheese at dose of 5Kgy to have high quality, safety and premium grade for the consumer.

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