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Safety improvement of creamed powder using gamma radiation and ozone

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Abstract

Food is a basic necessity for human survival, but it is still the vehicle for the transmission of food borne diseases. Various studies have examined the roles of milk and dairy products, making the need for safe and convenient methods of necessity decontamination. The current study determined the microbiological status of one hundred random samples of creamed powder (50 from large package samples bought by weight, and 50 small packages) were collected from dairy shops and markets in Cairo and study improvement of microbiological status of samples using gamma radiation and ozone.

It was obvious from the obtained results that the aerobic bacterial count (APC), coliforms, yeast and mould counts in the samples of large packaged creamed power with minimum and maximum values of <10 and $5x10^7$, <10 and $2x10^3$&<10 and $5x10^6$ respectively, while found in small packagedsuch count were <10 and $5x10^2$, <10 &<10 and <10 & 7.5x10, respectively.

Also, the results of isolation of some pathogenic microorganisms reveled that coagulase positive *S. aureus* and *E.coli* could be isolated from large packaged creamed powder, while *Salmonella* spp. And *Listeria* ssp. failed to be isolated from either large or small packaged cream powder sample.

The study of the effects of gamma radiation and ozone on microbial load revealed different reduction percentages on microbial counts.

Results were compared with thepermissible limits in Egypt, in addition to the public health significance of pathogenic microorganisms and measures for control were discussed.

Keywords: *Gamma radiation, ozone, creamed powder.*

Introduction

Food is the basic requirement of living creatures to sustain life as it provides energy to perform many activities **(Pal and Jadhav, 2013).** Since ancient times, milk and its products form a major part of human food and play a prominent role in the diet **(Pal, 2014)**. Milk and dairy products contain many nutrients, such as protein, vitamins, calcium, magnesium, zinc, etc, which are necessary for healthful living of humans of all age groups and both sex in rural and urban people worldwide.

A product prepared from milk is called as dairy product, which preserves the nutritive values of milk and makes it easily acceptable to consumers **(Uddin *et al*., 2011 and Das *et al.,* 2015).** Cream is defined as the part of milk that is rich in fat which has been separated by skimming or otherwise. Based on the fat content of the end product and production methods, cream may be divided into various categories such as single, double or heavy, half or light, whipping or whipped, light whipping cream and clotted cream **(Anonymous 1993, 1995, 1996 and 1999).** As well, processes vary considerably for each cream powder depending on the target use. However, the cream is separated from whole milk, pasteurized and then standardized. Standardizations' is a process of altering the composition (e.g. by adding skimmed milk) so that the final composition suits the target uses. When cream powders are for specific target uses, other ingredients can be added so that the

cream powders provide not only the fat but also other ingredients for that application, for example cream powder for ice cream having all the ingredients such as sugar or corn syrup, corn starch and egg yolk. The mixture can be homogenized at 45-65°C and then pasteurized by heating at 72°C for 60 sec.. The mixture is then spray, dried, cooled, packed and stored **(Tamime, 2009).**

Dairy powdered can be used in fortification of other dairy products **(Karam *et al.,* 2013),** as well as an ingredient in a wide array of food including sauces and confectionary **(Sharma *et al*., 2012)**, infant formula, sports dietary supplements and in foods for health recovery **(Gill *et al.,* 2001 and Lagrange *et al*., 2015).**

Ready to eat food products are consumed without any treatment between final production step and consumption **(Vrdoljak *et al.,* 2016)**. The high nutritious nature of dairy products make them especially good media for the growth of microorganism **(Lledenbach and Marshall, 2009)**.

Dairy products can harbor variety of organisms, including many zoonotic bacteria transmissible to man such as *Brucella abortus, B. melitensis, Campylobacter jejuni, Escherchia coli, Listeria monocytogense, Mycobacterium bovis, M. tuberculosis, Salmonella* spp*., Staphylococcus aureus* and *Yersinia interocolitica***,** which can causeserious diseases, especially in children, pregnant women, elderly and compromised individuals **(Pal, 2007 and FAO, 2013)**. During the production of various dairy products, it is impossible to avoid contamination of milk and milk products with microbial agents **(Singh *et al.,* 2011 and Pal *et. al*., 2018).**

Food irradiation has the ability to disrupt the micro organism DNA thereby prolonging shelf –life and enhancing food safety without detrimental effect on the sensorial and nutritional quality when applying the appropriate dose **(Mc Nulty, 1988;Molins, 2001 and Diehl 2000)**, as well as, all microorganisms have an inherent sensitivity to ozone **(Patil and Bourke, 2012)**.

Few studies have so far been done in this country on quality of powdered cream. Consumer doesn't have good idea about the quality of powdered cream that they are purchasing from the market. For this reasons present study was designed to evaluate the quality of powdered cream available in local market. Experiments were also conducted to improve quality of powdered cream by using gamma irradiation and ozone.

Materials and Methods

1-Sample collection:

A total of one hundred random samples of powdered cream (50 for large package 10kg) sold by weight and 50 for small (45 g) sold as package were collected from dairy shops and markets in Cairo.

The samples had shelf life more than one year and transferred to laboratory either in their package or in sterile plastic bags to be examined microbiologically to evaluate their status.

2-Microbiological examinations:

2-1Sample preparation:

A 25g portion of each sample was weighted aseptically into a sterilized stomacher bag contain 225 ml of sterilized 1%(w/v) peptone water and then homogenized using stomacher (lab. Blender 400,Seward lab.) to have a dilution of 10^{-1}.Further, 10 fold serial dilutions were prepared according to **ISO 6887-5:2010**.

2-2 Aerobic Plate Count (APC): APC values were determined according to **ISO 4833-2:2013**, Plate count agar was used and incubation at 30±1 °C for 72±3 h.

2-3 Coliform count:

The estimation of bacteria from the coliform group was performed according to **FDA,2017**, using Violet Red Bile Agar (VRBA) and incubate at 35°C for 18-24 h.

2-4 Enumeration of *Escherichia coli* (*E.coli*): determination of *E.coli* count was performed according to the method defined by **ISO 16649 -2:2001**,Tryptone Bile X-glucuronide agar (TBX) was used and incubation at 44±1°Cfor 18-24 h.

2-5 Determination of yeast and mould count: was done using Dichloran glycerol agar (DG18). Incubation at 25±1°C for 5 to7 day, according to **ISO21527-2:(2008)**.

2-6 Enumeration of *Staphylococcus aureus* : the determination of coagulase –positive staphylococci was performed according to **FDA 2000**.using Baird-Parker agar incubate at 35°C for 24-48 h. the identification of suspected colony was performed by detection of coagulase as well as catalase test, anaerobic utilization of manitol and glucose .

2-7 Detection of *Salmonella* spp.: The presence of *Salmonella* spp. was done according to **ISO6579:(2017)**. using Xylose Lysine deoxycholate (XLD) agar, incubation at 41.5±1°C for 24±3 h.

2-8 Detection of *Listeria monocytogenese*: was done according to **ISO 11290-1:(2017)**, using ALOA as a selective media and incubate at 37±1°C for 24-48 ±3 h.

3- Methods used for improvement the microbial status of creamed powder

3-1 Gamma–irradiation was carried out according to **Puligundla *et al.*, (2017)**: Samples (10g) were individually packed in poly ethylene bags, sealed and irradiated with 3, 5, 7and 9 kGy gamma ray, using Cobalt -60 (^{60}Co) as gamma ray source, in addition to non irradiated sample (0 kGy) were served as control.

3-2 Ozone treatment according to **Torlak and Sert, (2013)**:
Powdered cream samples were individually exposed to gaseous ozone at concentrations of

2.8 and 5.3 mg /l for 30 and 120 minutes, in addition to non–ozonated sample (0 mg/l) were served as control..

3-3 Sensory evaluation :Irradiated and ozonated powdered cream samples were evaluated by food hygiene staffs ,which were asked to indicate how much they liked or disliked each sample on a9 point hedonic scale (9:like extremely; 1:dislike extremely) according to flavor, taste, color and over all acceptability characteristics

4- Data analysis: All experiments were done in triplicates. Data were analyzed using (SPSS) program.

Results and Discussion

Food safety and food borne diseases constitute a growing public health problems **(WHO, 2009)**. Over 200 known diseases are transmitted through eating food contaminated by a variety agents including bacteria, parasite, viruses and fungi **(Oliver *et al.*, 2005)**. In addition to, food spoilage enormous economic problem worldwide. Through microbial activity alone approximately one-fourth of the world's food supply is lost **(Huis, 1998).**

The present study was investigated the microbial load of powdered cream produced in Egypt. The results depicted in table (1) & fig. (1) revealed that APC, yeast and moulds, and coliform bacteria were found in most 49 (98%) of the tested samples of large package ,with minimum value of <10, <10 and <10 cfu / g,maximum values of $5x10^7$, $5x10^6$ and $2x10^3$ cfu/g, and a mean values of $1.12x10^6 \pm 1x10^6$, $1.1x10^5 \pm 1x10^5$ and 6.55x10±4.08x10 cfu/g, respectively. Also 50(100%) of small package had APC, yeast and moulds, and coliform bacteria minimum and maximum values were ranged from <10 to $5x10^2$ cfu/g,<10 to 7.5 x10 cfu/g and <10cfu/g respectively, with an average count $1.26x10^2 \pm 2.68x10$, 1.6x10±0.25x10 and 5±0' respectively.

Many contaminant find their way to raw milk, from which they gain access to dairy products **(Al-khatib and Al-Mitwalli 2009 and Ismael *et al.* 2009)**.

Table (1). Statistical analytical results of microbial counts of examined cream powder samples:

Sample	N*	APC			Yeast &mould count			Coliform count		
		min	max	mean± SE	min	max	mean±SE	min	max	mean±SE
Large package	50	<10	$5x10^7$	$1.12x10^6$± $1x10^6$	<10	$5x10^6$	$1.1x10^5$± $1x10^5$	<10	$2x10^3$	6.55x10± 4.08x10
Small package	50	<10	$5x10^2$	$1.26x10^2$± 2.68x10	<10	7.5x10	1.6x10± 0.25x10	<10	<10	0±0

*N :50 sample of each **SE: standard error for positive samples only.

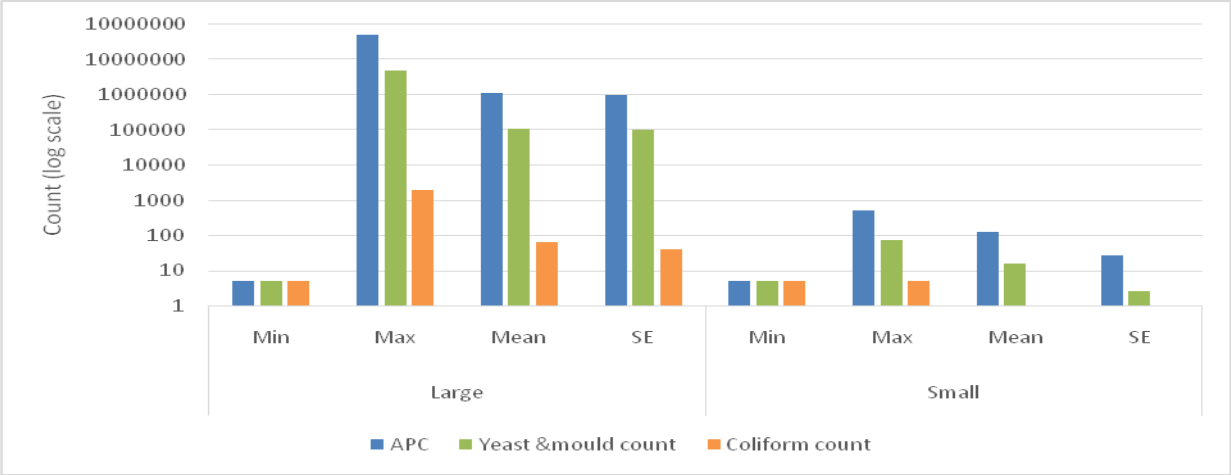

Fig. (1): Statistical analysis of microbial counts in examined cream powder samples

The microbiological quality of milk and dairy products was influenced by the initial flora of raw milk. The processing conditions and post – heat treatment contamination **(Richter *et al.*, 1992). Uddin *et al.*, (2011)** reported that the milk contains relatively few bacteria when it is secreted from a healthy animal. However, during milking operations, it gets contaminated from exterior of the udder and the adjacent areas, dairy utensils, milking machines, the hands of milking man, from the soil and dust .In these way bacteria, yeasts and moulds get entry into the milk and thus constitute the normal flora of milk. **Pal *et al.*, (2018)** stated that contaminated evaporators used for the manufacturing of dried milk products may act as potential source of microbial contamination, so they should be properly cleaned and sanitized. Also, **Pal and Mahendra (2016)** showed that all vacuum pans, pipelines, concentration tank, packaging room and storage container must be thoroughly cleaned and sanitized, besides filter pads need periodical cleaning to remove the accumulated dust,. this steps are necessary for the production of high quality of milk powder to gain long shelf life.

The high APC in large package tested samples were nearly similar to those obtained by **Marwa and Lamiaa (2013)**.but the APC of small package tested sample were higher than reported by **Nazem *et al.* (2015)**. A high APC level in general , is indicative of the possible presence of harmful organisms and makes the food unsatisfactory for human consumption **(Gilbert *et al.*, 2000 and Gillespie and little, 2000)**. The yeasts and moulds count in large package tested sample obtained in the present study study were higher than reported by (**Marwa and Lamiaa, 2013** and **Nazem *et al.*,**

2015). Presence of yeasts and moulds in dairy products is objectionable as they grow at a wide range of temperature and pH values resulting in spoilage of the product. They may contaminate the product from many different sources. Thus yeasts and moulds count in some countries are considered a standard test for checking factor sanitation **(Foster *et al.*, 1983)**. The coliform count of large package tested samples was extremely lower than that obtained by (**Nazem *et al.*, 2015)** .Coliform as well as *E. coli* are often used as indicator microrganisms, so their presence in food implies poor hygiene and sanitary practices **(Arafa, 2013 and Bakhshi *et al*., 2017).**

The reported result in table (2)& fig(1) indicated that out of 50 each of large and small package sold by weight in plastic bag, E. coli was prevellent in 2 (4%) and 0 (0%) respectively, while 4(8%) and 0(0%) for *S. aureus* respectively. The mean values of *E. coli* and *S. aureus* in large packages were 15±1, 3.25 x10 ±5.5 respectively.

Table (2). Incidence of some food borne pathogens in examined cream powder samples

	E. coli						*Staph. aureus*					*Salmonella*		*Listeria*	
	No	**Positive**	**%**	**min**	**max**	**Mean± SE**	**No**	**%**	**min**	**max**	**Mean± SE**	**No**	**%**	**No**	**%**
Large package	50	2	4	10	20	15±1	4	8	5	60	32.5±5.5	0	0	0	0
Small package	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*SE: standard error for positive samples only

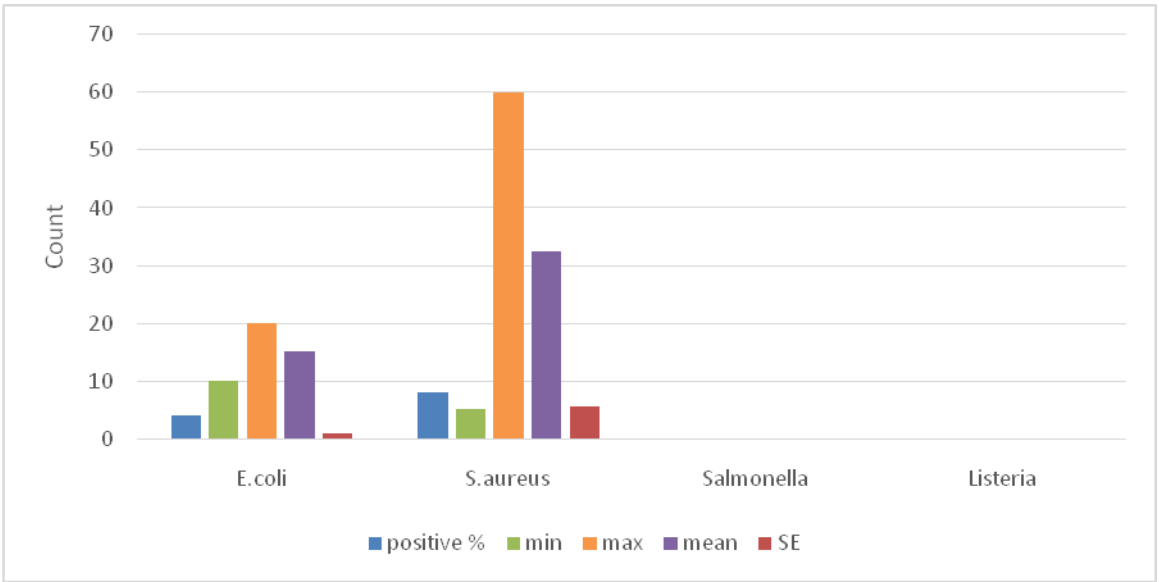

Fig. (2): Statistical analysis of microbial counts in examined cream powder samples

The obtained result was in agreement with that stated by (**Marwa and Lamiaa, 2013** and **Nazemm *et al*., 2015**) for sample of large package while contrast with them as regard to sample of small package .

Arafa (2013) reported that total coliform and fecal coliform were detected in 89.5 and 65.8 %of examined raw milk sample with mean counts of $1.65x10^6$ and $3.69x10^5$ MPN/ml, respectively. *E coli* was isolated from 52.6% of raw milk samples. Similar work reported mean total coliform count of $3.28x10^2$ - $1.4x10^3$ cfu /ml with the dominant isolated colifom of 8% *E. coli* ,14% *salmonella* spp. **(EL-Leboudy *et al*., 2014)** shoed the presence of *E. coli* in raw milk and the number reduced in the heat treated one. Milk and its derivatives are considered as a major source 0f *S. aureus* infection in man **(Jahan *et al*., 2015, Sarkar *et al.,* 2014)** documented 74.5% (149/200) of milk samples were positive for *S. aurus.*

The recorded data in table (2) & fig. (1) revealed that *salmonella* spp. and *l. monocytogenes*. Were not recovered from any of the tested samples. These results was in agreement with **(Varga 2007)** stated that non of pasteurized and UHT milk sample surveyed contain detectable level of *salmonella* spp. and *L. monocytogenes*.

Regarding to compare the maximum tolerated limits in the current study with the EgyptianS-landered,780-1:2014 (milk powder and cream powder), it is of importance to emphasize that 36and 50 of large package and small package sample respectively, were accepted.

The sensory evaluation of irradiated powdered cream was determined as flavor ,taste ,color and overall acceptability which did not alter upon 5kGy while mild changes occurred in 7 and 9 kGy treatment. on the other hand, the sensory evaluation of ozonated sample using 2.8 and 5.3 mg/l treatment for 30 mints cause mild change in flavor, taste, and overall acceptability while not change the color but 2.8 and 5.3 mg/l treatment for 120 mins cause extremely change in flavor, taste and over all acceptability but colorremain acceptable.

It is cleared in (table 3& fig 3) that gamma rays at a dose of 5kGy and 5.3 mg/l ozonation can be used for improving the microbiological statues for creamed powder without compromising its sensory properties.

Table (3). Effect of gamma radiation and ozone treatment on creamed powder .

	Treatments	**APC**	**Reduction %**
Gamma radiation	0 kGy	$1.83x10^7$	0
Gamma radiation	3 kGy	$3.63x10^5$	98
Gamma radiation	5 kGy	$6.80x10^4$	99.62
Gamma radiation	kGy7	$5.37x10^2$	99.99
Gamma radiation	9kGy	4.17x10	99.99
Ozone treatment	0 mg/l	$1.83x10^7$	0
Ozone treatment	2.8mg/l for 30 min.	$7x10^6$	62
Ozone treatment	2.8mg/l for 120 min.	$2.87x10^6$	84
Ozone treatment	5.3 mg/ l for30 min.	$1.83x10^6$	90
Ozone treatment	5.3 mg /l for 120min.	$2.87x10^5$	98

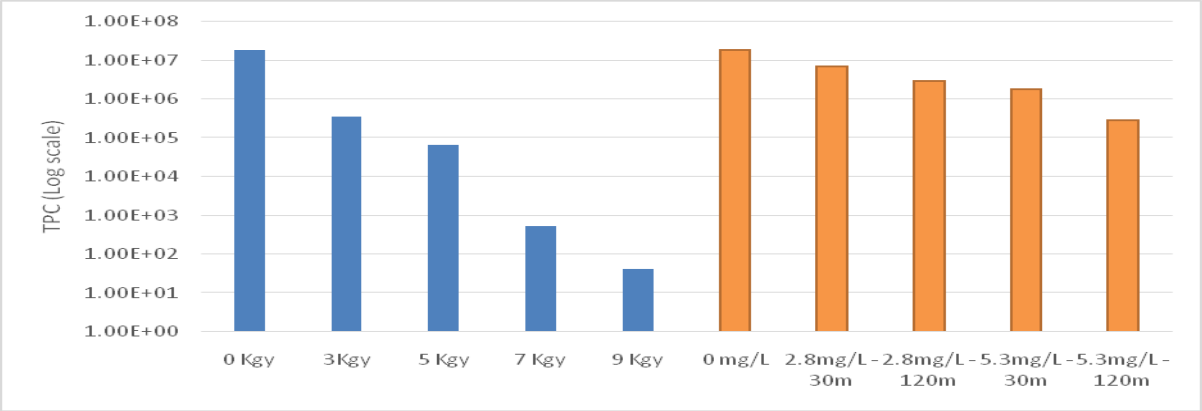

Fig. (3): Effect of gamma radiation and ozone treatment on creamed powder

Conclusion and recommendations

This study demonstrates the presence of some pathogens including *Staph. aureus* and *E. coli* in creamed powder as well as high microbial load.

Therefore, these foods are of serious risk to public health. Likewise, the presence of these organisms indicated that there were poor hygienic condition during manufacture, storage, handling and sales process of that product.

Manufacturing procedures within scope of the ISO 22000:2018,appropriate hygienic measures to avoid processing and post processing cross contamination and the use of pasteurized ingredients are critical required for control of these pathogen in these foods.

We need to increase consumer awareness to choose food from reliable and safe sources in well-handled conditions, directing the attention of producers towards modern methods in order to improve the microbial status of the product which subsequently leads to reducing the economic losses.

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