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SAFETY AND QUALITY OF SOME IMPORTED MILK POWDER SOLD IN THE EGYPTIAN MARKET

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ABSTRACT
Different samples of full and skim milk powder were purchased from imported sources in Egypt, the samples were undertaken and analyzed to stand up on some functional properties as solubility, bulk density, total soluble solids T.S.S. and dispersibility, chemical composition as moisture content, total solids, fat, lactose, protein and ash, microbiological quality as well as detection of radiation. However, the results of almost functional properties and chemical composition of the samples fall within the permissible standards. On the other hand the total colony count, Aerobic spore former count, mould and yeast count, *Enterobacterial* count, *Coliform* count, *Enterococci*, *Staphylococci*, and *Pseudomonas* and *Aeromonas* count were examined in both full and skim milk powder samples as well as determination of aflatoxin M_1. *Salmonella*, was not detected in all examined milk powder samples. Also the detection of radiation reflected no radioactive contamination of the examined samples.

KEYWORDS: solubility, bulk density, total soluble solids, aflatoxin M_1, radioactive contamination.

INTRODUCTION

A variety of food products are available at the retail level, packaged in cans with reduced oxygen atmosphere to prolong shelf life. These products are often stored for extended periods of time before being opened, and thus the quality at the time of retail sale is often unknown to the consumer. Among these food is milk powder. Dried milk powder must exhibit high quality in sensory, nutritional and microbiological attributes at the time of purchase if quality is to be maintained during long-term storage (Hough *et al*., 2002). In many developing countries, *e.g*. Egypt, the shortage in the milk supply requires increasing use of milk powder. So, this research discussed the properties of full and skim milk powders which must be optimized to give consumer satisfaction. The consumer reconstitutes the milk powder whether add it to hot beverages, frozen desserts, cheese, yoghurt, bakery products, soaps and infant formula to make their nutritional content the same as the existing food (Liod *et al.,* 2005). In spite of the high temperature attained in its processing, the dairy industry has always been conscious of the microbiological hazards associated with milk powder. It may be responsible for transmission of some diseases to consumers as food poisoning specially with *Salmonella*, *Enterococci* and *Staphylococci* (Blank *et al*., 2004). Aflatoxins are carcinogenic, mutagenic and teratogenic metabolites produced by *Aspergillus flavus* and *Asergillus parasiticus*. The ingestion of aflatoxin B_1 in feedstuffs by the dairy animals lead to the excretion of aflatoxin M_1 in the milk and milk poroducts. The amount of aflatoxin M_1 in milk was estimated as less than 1% of the ingested aflatoxin B_1 in the ration. (Diaz *et al*., 2005). Food contamination by the radio nucleotide and the activity of the natural and total gamma contamination would be tested to stand up on the activity levels measured in the milk powder. The permissible level of radionuclide in foods was 600 Bq/Kg (Duric and Popovic, 1997). However total radioactivity ranges (Bq/Kg) were 251.49-451.24 and 350.36-475.05 in dried full and skim milk samples respectively (Skibniewska *et al.,* 1993). On the other hand, several irradiated consumed food on different scales through commercial channels as carried out on milk (Naguib *et al*., 1973) and (Khorshid *et al*., 1976), Ras cheese, (El-Batawy, *et al*., 1987 and 1988); butter oil (Khorshid, 1972); dried milk (Iuzac, 1970); yoghurt and Domiati cheese (Ibrahim, 1984); skim milk (Heikal *et al*., 1992) and milk powder (Duric and Popovic, 1997). Furthermore it might be signed to the imported quantity of skim and full milk powders, however it represent about 21847.240 tons during the year 2003, and 26600.007 during the year 2004, the importation was from different countries over the world mainly Sweden, France, Poland and Nyasaland for skim milk and Nyasaland, Denmark, England and Holland for full milk, however it cost the government around 81 million dollar per year according to the commonalty Authority for the censorship on the exports and imports in Egypt. As the microbiological and radioactivity of milk powder reflects the care with which the milk powder was produced and the sanitary conditions prevailing during its manufacture, this work was planned to investigate the physico-chemical properties, microbiological examination, detection and determination of aflatoxin M1 as

well as detection of radioactive nucleotide in the examined full and skim milk powder samples.

MATERIALS & METHODS

Samples of both of skim and full milk powder were purchased from common imported sources of it in Egypt.

a) Skim milk powder (SMP), pasteurized low heat was collected from Aria foods (Sweden). Dina comp. and Swedish (SMP) ADPI Extra grade.
b) Full milk powders (FMP) were obtained from common trade kinds.

1. Chemical composition analysis

Skim and full milk powders (SMP, FMP) were examined for its fat % (BSI, 1955), moisture content %(Mc) and ash% (AOAC, 1990); total nitrogen % as indicator for protein content) using micro kjeldahl method (IDF, 1962), and lactose as described by (Dubois et al, 1956).

2. Functional properties

The solubility of the samples was determined according to (Varnam and Sutherland 1994) the dispersibility was tested following the method given by the (ADMI 1965). The bulk density according to the procedure described by (Sjollema 1963), and total soluble solids (T.S.S) was determined by Hand Refractometer ATTAGO co., LTDmodel502132 (Japan) with range of 0-32%**.**

3. Microbiological examination

3.1 Total colony count

One ml of decimal dilutions were plated into standard plate count agar media and incubated at 37ºC for 24 h according to International Commission on Microbiological Specification for foods "ICMSF" (1996).

3.2 *Aerobic spore former* count according to American Public Health Association "A.P.H.A" (1992)

3.3 *coliform* count (MPN/ml) according to A.P.H.A (1992).

3.4 *Enterococcal* count according to ICMSF (1996).

3.5 *Pseudomonas* and *Aeromonas* count as recommended by Marshall (1992).

3.6 *Staphylococcal* count (coagulase positive) according to Nathalie and Gueguen (1997).

3.7 Total *mold* and *yeast* count were perfomed according to Gourama and Bullerman, (1995). Isolated *molds* were subjected for identification according to their morphological and microscopical characters according to Pitt and Hocking (1997).

3.8 Isolation of *Salmonella* according to ICMSF, (1996)

4. Determination of aflatoxin M_1

Milk samples were performed using indirect enzyme linked immunosorbent assay (ELISA) according to (Scott, 1995).

5. Detection of Radioactive nucleotide

The samples of both of full and skim milk powder had been submitted to radioactivity measurements using a single channel analyzer (nucleus USA) by window for Cs^{137} & Cs^{134} and without window according to Clardy *et al*. (2002).

RESULTS & DISCUSSION

1. Chemical compositions

Both of SMP and FMP were analyzed for chemical as shown inTable -1.

1.1 Moisture content (MC):

Mc in the analyzed samples fall within the permissible standard for (SMP), the mean was 2.5% and 3.15% in FMP and SMP resp., corresponding to 3.88%, 3.4% (Mc) in SMP according to (Arora, 1989) and (ADMI, 2003). The difference of (Mc) value between both of (FMP) and (SMP) can be attributed to the fat content in full milk, also, to the water of crystallization in SKM and the excess amount of crystallized lactose of it than that of (FMP) as illustrated in the same table. However, it constitute almost half the solids present (51.2%) corresponding to 38.85% in FMP and that in agreement with Mistry (2002).

1.2Total solids (T.S): data as presented in Table (1) show that the values higher of MC lower were the T.S. content, and vice-versa, as MC and T.S are dependent upon each other.

1.3 Fat: the values of fat content varied from 26.9 to 27.3% with the mean 27.15 in FMP and 0.5 to 0.7% with the mean 0.6 in SMP. The difference attributed to differentiation the fat content of raw milk or the additive fat to calibrate the final amount depending upon the product whether skim or full milk powder. The values of fat in (FMP) were in agreement with the results obtained by sarmah *et al*. (1989) by using atmospheric and vacuum roller during whereas 27.27 to 27.61%. However, SMP fat values were in agreement with the corresponding ones in India 1.10 (0.13-2.67) and 1.19 (0.32-1.95) by using spray and roller drier resp., (Arora, 1989). While comparatively higher values were detected with ADMI (2003) whereas were 0.61 to 1.25%.

1.4 Lactose: the mean was 37.85% and 51.2 in FMP and SKM resp., it confirm almost half the solids present in the latter, that disagreement with ADMI (2003) whereas 49.5 to 52%. The higher values of lactose in SMP when comparing to the others in FMP might be attributed with the increase of fat content which reflecting in the reduction of the solid not fat content in the FMP than SMP.

1.5 Protein and ash: with regards to protein the mean represented 26.1% and 36.2% for both FMP and SMP respectively. However as expected the reduction of SNF content in FMP reflecting in reduction of protein content also. Furthermore as evident by ADMI (2003) protein was 34-37% in SMP so protein content in the under taken milk powder fall within permissible standard. The same could be noticed with ash whereas 5.9% and 8.3% in FMP and SMP resp., corresponding to 8.2% to 8.6 within ADMI (2003) and Arora (1989) for SMP. So, it could be concluded that samples undertaken of both SMP and FMP fall within permissible standard according to Egyptian Standard (2005). Furthermore SMP characterized by high content of SNF moisture, protein, lactose and ash content than FMP which contained 27.15% fat content corresponding to 0.6% in SMP.

TABLE 1: some chemical composition of milk powders

Parameters components	Average and values	FMP	SMP
Moisture (%)	Max	2.6	3.3
	Min	2.4	3.2
	Mean×	2.5	3.15
Fat (%)	Max	27.3	0.7
	Min	26.9	0.5
	Mean	27.15	0.6
Protein (%)	Max	26.2	36.4
	Min	26.0	35.9
	Mean	26.10	36.2
Lactose (%)	Max	38.0	51.2
	Min	37.8	51.2
	Mean	37.85	51.2
Ash (%)	Max	6.0	8.5
	Min	5.9	8.3
	Mean	5.95	8.4

Mean×= mean of14 samples of each type

2. Functional properties

2.1 Solubility: As illustrated in Table (2) the increase of total solids result decrease solubility. However, the higher solubility was in case of 10% than 16% in both of reconstituted SMP or FMP, they represented 95% -92% corresponding to 88% and 85% resp., Furthermore, solubility of (SMP) was greater than that of the (FMP) which was mainly due to the accomplishment of (SMP) (low temp.) which causes lesser denaturizing of the proteins as reported by (Sarmah *et al*., 1989) they added that full milk dried by (ADD) (atmospheric roller drying) had higher solubility index whilst skim milk showed lower solubility. While (Baldwin and Ackland, 1991) found that solubility index (SI) was significantly affected by preheat holding time only. However,(Metwally and Awad, 2001) concluded that low heat reconstituted skim milk powder (RSMP) more soluble than that of high heat and less than cows' milk (as control) whereas 98.5%, 95.0% and 99.0% respectively, whilst (Arora, 1989) found that solubility index (SI) was 0.23 (0.01 – 1.5) for RFMP, also, ADMI (2003) advised that (SI) for SMP is < 1.2 ml.

2.2 Total soluble solids (TSS): An over view on the rate of solubility (RS) which mean the result of T.S.S (by Refracto meter) divided by conc. of reconstituted milk powder (RMP) per gm/ 100ml water. The (RS) increased in reversible proportion with RMP conc. However, it was 87% with 10% (SMP) conc., corresponding to 71.8% with 16% (SMP) conc. Furthermore, it was 85% and 70.6% corresponding to 10% and 16% FMP conc. resp.,

2.3 Bulk density: As summarized in table (2) the mean of bulk density represent 0.8768/cm-3 and 0.569 g/cm-3 in both of SMP and FMP resp., however, high milk protein powder (HMPP) of skim milk had loose and packed densities than non fat dry milk (NDM) but true densities of both powders were similar (Mistry and Pulgar, 1996).

2.4 Dispersibility: The mean of dispersibility of (FMP) as presented in Table (2) was more less that obtained with SMP, the values were 13 sec. and 145 sec. resp. Sarmah *et al*. (1989) reported that atmospheric roller drying (ARD) milk had lower bulk density and dispersibility than vacuum roller drying (VRD) milk in both full and skim milk.

TABLE 2: Functional properties of reconstituted l milk powders

	SMP				FMP			
Conc. g/100ml water	10%	12%	14%	16%	10%	12%	14%	16%
Solubility	95%	95%	90%	88%	92%	90%	88%	85%
T.S.S×	8.7%	9.2%	10.1%	11.5%	8.5%	9%	10%	11.3%
Rate of solubility	87%	76%	72%	71.8%	85%	75%	71.4%	70.6%
Mean of bulk density	0.876 g/cm^{-3}				0.569 g/cm^{-3}			
Mean of Dispersibility	145 sec.				13 sec.			

T.S.S = total soluble solids (by refract meter).

Rate of solubility = T.S.S / concentration of reconstituted milk powder g/100ml water.

3. Microbiological analysis

As shown in Table (3a,b,c,d,e,f,g,) 100% of the examined samples had total bacterial count with averaged mean from $13\times10^4 \pm 2.9 \times 10^3$ to $9 \times 10^5 \pm 3 \times 10^3$ cfu/g in both full and skim milk powder samples respectively. However, Aerobic spore formers and mould and yeast count were presented in 84% & 100% with a mean value of averaged from $11\times10^3 \pm 8 \times 10^2$ to $29 \times 10^3 \pm 1.3 \times 10^2$ and $9 \times 10 \pm 2.1 \times 10^2$ to $17\times10^3 \pm 6.1\times10^2$ respectively. *Enterococi*, *Coliform* and *Staphylococci* were presented in 51% , 39% and 55% with an average of $3.4 \times 10^2 \pm 1.1 \times 10$ to $26\times10^3 \pm 12\times10^2$ & $2.9 \times 10^2 \pm 1.1\times10$ to $17\times10^2 \pm 0.03\times10$ and $8.8\times10^2 \pm 0.03\times10$

to 23×10^2 ± 1.1×10 CFU/g respectively, Furthermore *Enterobactrial* and *Pseudomonas and Aeromonas* count/g were found in 19% and 29% with a mean value of 1×10 ± 0.9×10 to 9.2×10 ± 0.08×10 and 1.1×10 ± 0.01 to 13×10^2 ± 0.01×10 cfu/g respectively (Table . *Salmonella* could not be isolated from all samples. It should be known that Aerobic spore forming bacteria produce heat resistant spores, the spores are ubiquitous and are extremely that a large proportion of the bacteria which contaminate the product had gained access to the product undertaken careless during production, handling and distribution. However, the high content of spore forms may be due to the presence of *Bacillus licheniformis* and *Bacillus cereus* which were the most common Bacillus species (Grielly *et al*., 1994). The first one was ubiquitous in farm environment and counts in raw milks while the later associated with cattle feed, it was also isolated in larger numbers in raw milks, reconstituted milk powder and its domination associated with enterotoxin production. Furthermore Geobacillus stearothermophilus represented 56% of 141 isolates of Thermophilic Bacilli according to Flient *et al*. (2001). For moulds the public health importance has been emphasized certain species can produce mycotoxins which are implicated in human cases of food poisoning and neoplastic disease including leukemia and other cancers Bullerman (1980) while some species of yeasts constitute a public health hazard such as gastrointestinal disturbances (Jaquet and Teheran, 1976). Presence of coli form is considered as index of unsatisfactory sanitation and possible presence of enteric pathogens. On the other hand the counts of coli form, yeasts, moulds and total count were in disagreement with (Barrantes and Tamime,1992) and (Barrantes *et al*., 1994) whereas coli form, yeast and fungi counts were less than 10 cfu/g before incubation of yoghurt made with dried skim milk while total count of non lactic acid bacteria were less than 100 cfu/g. However Yetismeyen and Uraz (2000) found that counts of coli forms and yeasts/fungi in the cow milk powders were 2-6 and 16-26/g respectively. Bacterial count varied greatly among samples (range 48000-181000/g). It's recommended that *Enterococci* count be added to the standard indices of hygienic quality of baby foods Aleksieva (1974). In food microbiology *Streptcoccus faecium* is of importance (F.A.O. 1979) according to the suggested microbiological limit by the UNICEF for Lancefied group D streptococci count/g. as enterocci being a normal inhabitant in the intestinal tract of man and animals, thus their presence in product is indicative of faecal contamination and consequently of unsanitary production and handling of the product (Angelotti *et al*., 1963) and Brooks, (1974). The low recovery of Enterobacteriaceae from dried food samples was due to the sub lethal impairment of these microorganisms during the drying process (Mossel and Vincentie, 1969). However enterobacter species as Klebsiella and Proteus were incriminated in urinary tract infection and septicemia (Bailey and Scott 1974) beside some cases of summer diarrhea in infants (Frazier, 1976).

Salmonella was not isolated in all the examined samples undertaken and that in agreement with ADMI (2003) recommendation. Whilst, they were detected by Leberage *et al.* (1997) It could be signed to the high content of viable total count and coli forming examined in milk powder samples. Comparing to the recommended level of microbiological analysis for standard plate count and coli form which were not more than < 300.000/g and 10/g for both respectively, according to ADMI (2003).

4. Determination of aflatoxin M1 (AFM1)

Aflatoxin M_1 was detected in 66% of the examined samples with a mean value of 141.9 and 159.0 ng/kg in full and skim milk powder respectively (Table 4). Nearly similar finding were reported by Kawamura *et al*. (1994) and Bonessi *et al.* (2003). Lower results were recorded by Markaki and Melissari (1997) and Olivera *et al.* (1997) while higher results were obtained by Aman, (1995) and Hassanen, (1996). On the other hand, the regulatory limits for (AFM1) in milk are 200, 50 and 50 ng/L in France, Italy and Switzerland (Galvano *et al*., 1996), 500 ng/l in USA (FDA, 1994). While in Egypt, it's free whether in milk, cheese or infant formula according to Egyptian standard (2005). Aflatoxins are produced by certain mould species especially *Aspergillus flavus* and *A. parasiticus*. It is not destroyed by prolonged autoclaving (Varnam and Sutherland, 1994). However, AFM1 had hepatocarcinogen in the trout carcinogenicity assay, when AFM1 at 8 mug/kg incorporated into dairy cow rations that might have been carried over into milk (Bailey *et al*., 1994 and Piva *et al*., 1995). It has been shown that the AFB1 in foodstuffs is excreted with milk in a form of toxic metabolite, Aflatoxin M_1 (Varnam, and Sutherland, 1994 and Gourama, 1997). Heat treatments of milk do not cause an appreciable change in the amount of aflatoxin M_1 level (Bailey *et al*., 1994; Piva *et al*., 1995 and Salwa, 1999). It is responsible for serious public health hazards among heavily consumers especially infants and children. It is highly toxic, mutagenic, teratogenic and carcinogenic compound that have been implicated as causative agent in human hepatic and extrahepatic carcinogensis. It affect vascular system leading to increased vascular fragility and hemorrhage into body tissues, digestive system leading to diarrhea, vomiting, liver necrosis and liver fibrosis, respiratory system leading to respiratory distress, bleeding from lungs and immune system leading to immune suppression (Massey *et al*., 1995 and Diaz *et al*., 2005).

TABLE (3a, b, c, d, e, f, g, h, I, and 4) Hygienic quality of milk powders

TABLE 3a: Statistical analytical results of total viable bacterial count/g in examined samples:

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	45	10	7×10^5	13×10^4 ± 2. 9×10^3
SMP	45	45	35	14×10^5	9×10^4 ± 3.0×10^3

TABLE 3b: Aerobic spore former count/g:

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	36	20	23×10^5	$11\times10^3 \pm 8\times10^2$
SMP	45	40	30	49×10^5	$29\times10^3 \pm 1.3\times10^2$

TABLE 3c: Statistical analytical results of *Coliform* (MPN/g) in examined samples

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	14	40	23×10^3	$2.9\times10^2 \pm 1.1\times10$
SMP	30	21	60	60×10^3	$17\times10^2 \pm 0.03\times10$

TABLE 3d: Total mold and yeast count

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	45	15	16×10^4	$9\times10^3 \pm 2.1\times10^2$
SMP	45	45	30	8×10^4	$17\times10^3 \pm 6.1\times10^2$

TABLE 3e: Statistical analytical count of *Entercocci* count/g in examined samples

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	16	10	49×10^3	$3.4\times10^2 \pm 1.1\times10$
SMP	45	30	10	59×10^4	$26\times10^3 \pm 12\times10^2$

TABLE 3f: Incidence of *Staphylococci* count in examined samples

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	20	10	19×10^3	$8.8\times10^2 \pm 0.03\times10$
SMP	45	30	20	60×10^3	$23\times10^2 \pm 1.1\times10$

TABLE 3g: Incidence of *Enterobacterial* count/g in examined samples

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	6	10	2×10^2	$1\times10 \pm 0.9\times10$
SMP	45	11	15	19×10^2	$9.2\times10 \pm 0.08\times10$

TABLE 3h: *Pseudomonas* and *Aeromonas* count/g

	No. of sample	Positive	Min	Max	Mean ±
FMP	45	12	10	8×10^2	$1.1\times10^3 \pm 0.01$
SMP	45	14	30	26×10^3	$13\times10^2 \pm 0.01\times10$

TABLE 4: Incidence of aflatoxin M1 ng /Kg in examined milk powder

	No. of sample	Positive	Min	Max	Mean ±
FMP	30	15	25.9	187.1	141.9
SMP	30	26	55.0	280.0	159.0

5. The detection of Radiation

Representative samples of FMP and SMP were tested for occurrence of radio nuclei the radio activity assay by using single channel analysis revealed that all samples did not show any radioactive contamination. However the powdered milk samples obtained from Gechoslovakia in 1986 (after Chernobyl accident was 0.81-1.31Bg/Kg (Bem et al 1991), while the permissible level of radio nuclides in foods were (600Bg/kg) in the year 1995(Duric and Popovic, 1997) so, the use of both of SMP and FMP undertaken are safe and did not present significant Sources of radio contamination to consumers if it used mainly as raw materials or as additives in foods.

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