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Quality Assessment of Milk Powders Packed in Sudan

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Abstract: Physicochemical, microbiological and sensory characteristics of milk powders packed in Sudan were investigated and compared with international quality standards. The compositions (moisture, fat, protein, ash and lactose) of the locally packed milk powders are almost insignificantly different ($p \leq 0.05$) and they are comparable to the compositional quality in US and Argentina. Despite the significant ($p \leq 0.05$) variations in acidity and pH between milk powder samples, their levels remained within the acceptable standard levels. Results also showed that most milk powders packed in Sudan had partial solubility in water, in comparison with the instantly soluble standards. Microbiologically the samples were safe, but organoleptically they considered of fair quality.

Key words: Milk powder, physicochemical quality, microbiological quality, organoleptic quality

INTRODUCTION

Cow's milk is ranked first in the world. Meanwhile, it is considered one of the main components of the human diet in many parts of the world. It contains all essential nutrients. Most Cows' milk is consumed in the fresh or processed state. Processing treatments, with the aim of extending shelf life, have direct influences on the nutritional, biological and functional properties of milk nutrients (Nickerson, 1999; Ahmad *et al*., 2008).

Milk powder manufacture is a simple process now carried out on a large scale. It involves the gentle removal of water at the lowest possible cost under stringent hygiene conditions while retaining all the desirable natural properties of the milk; color, flavor, solubility and nutritional value. The milk powder contains lactose (38%), protein (26%), fat (26%) and ash (6%) in the same proportions as fluid milk (Eckles, 2001). Manufacture of milk powder was found abundantly in many developing countries because of reduced transport and storage costs. Standard powders, because of their fine dusty nature, do not reconstitute well in water. Agglomerated and instant powder was specially developed to counter this problem (Eckles, 2001). The milk powder is produced in three forms, full cream (26% fat), partially skimmed (8-24% fat) and skimmed (1.5% fat) milk powders for animal food in which fat not more than 1.5%. Milk powders with a standard fat content usually traded commercially for a variety of dairy and food application end uses (FAO, 1993; Keogh *et al*., 2003). The primary objectives for the thermal processing and drying of milk, in general, are to reduce natural pathogenic and spoilage microorganisms, to extend the shelf life of the milk and to ensure the safety of milk for human consumption. So, that the product can be consumed while still remaining safe, retaining acceptable quality and meeting customer expectations (Man and Jones, 1999).

However, several factors may contribute to changes in its physical and chemical properties which reduce shelf-life and thus its commercial value. Different researchers agree that the hygienic conditions under which raw milk is produced are the main factor affecting powder quality. Storage temperature and transportation may also influence the properties of milk powder, especially its solubility index and acidity (Fernandes de Oliveira *et al*., 2000; Eckles, 2001). To evaluate the quality and acceptability of a product, it is necessary to identify the characteristics of the constituents, the process and the storage conditions responsible (Man and Jones, 1999; Fernandez-Molina *et al.*, 2005). Milk powders should be evaluated organoleptically, physicochemically and microbiologically to fully determine the quality and condition (USDEC, 2001).

In the recent years, many factories in Sudan had licenses for packing international brands of milk powders, such as Muawia Elberair Food Industry Company (Lodo), Blue Nile Dairy Company (kapo) and Gobber Food Stuff (Al marrai). However, little information is available on the quality of milk powders packed in the country. Therefore, the aim of this study was to investigate on the quality of the different brands of milk powder packed in Sudan in order to grade their quality in relation to the worldwide standards.

MATERIALS AND METHODS

Milk powder samples: Milk powder samples from different commercial brands (Kapo, Foremost, Al-marrai, Al-prince, Lodo and Nido) were purchased from the

supermarkets in Khartoum state, Sudan. All the samples were packed (in metal cans) in Sudan. The milk powder of Nido brand was imported from Netherlands and used as control.

Compositional analysis: The moisture content of the milk powders was determined by the oven drying (105^{o}C) method (AOAC, 1990). Ash was determined after mineralization of milk powder at 550^{o}C according to AOAC (1990) and pH was measured using a pH meter (Hanna_pH 210). Total nitrogen was determined by the Kjeldhal method (Bradley *et al*., 1992). Nitrogen content was converted into equivalent protein content using 6.38 as a converting factor (Karman and Van Boekel, 1986). Fat content was determined using Gerber method according to Bradley *et al.* (1992). Lactose was determined by the anthrone method (Richard, 1959). Powder samples were assayed for titratable acidity (% lactic acid) according to the method of Marshall (1992). Solubility in water was determined according to the standard method of AOAC (1990).

Organoleptic tests: Sensory evaluation tests for milk powder samples were done according to the British Standards methods (BS, 1986). Where, 10 g of milk powder were reconstituted in 90 g of water (colorless, tasteless and of excellent microbial quality at 25°C). The powder was mixed thoroughly in the water and then held in a covered glass container (in the dark) for about an hour at 20^{o}C before evaluation. The reconstituted milk is examined for color, taste, flavor and odor and appearance.

Microbiological analyses: Microbiological analyses were performed on samples of milk powder following the procedures of the International Commission for Specification for Food (ICMSF, 1978). A tenfold serial dilutions up to 10^{-6} for each sample were prepared in 0.1% peptone water and subsequently plated onto standard Plate Count Agar (PCA) and Macconcey Agar (MA) to count total aerobic and coliform bacteria. PCA plates were incubated for 48±2 h at 32 ±1°C. MA plates for coliforms were incubated for 24±2 h at 32±1^{o}C. The colony forming units (cfu) and the most probable number were employed to count total bacteria and coliforms, respectively. The results of microbiological assays were reported in duplicate.

Statistical analysis: Average results of triplicate samples were submitted to statistical analyses. Results were analyzed using analysis of variance of the SAS Institute-version 6.3-(SAS, 1997). Significant differences between means were determined at $p \leq 0.05$.

RESULTS AND DISCUSSION

Physicochemical characteristics

Moisture, protein, fat, ash and lactose contents: Proximate composition of the milk powders is presented in Table 1. The moisture contents of the local commercial milk powders (Kapo, Al-marrai, Foremost, Al-prince and Lodo) ranged between 2.06-2.40%, compared to 2.25% for the control Nido sample (Table 1). A significant ($p \leq 0.05$) variation in moisture content of samples was observed. Physicochemical stability of milk powder during storage and distribution varies with the water content. Additionally, technological functionalities like dissolution or wettability can also be affected by the water content (Reh *et al.*, 2004). The findings of this study indicated that the moisture content of all samples are lower than the recommended standards of Sudan (SSMO, 1999), USA (FDSPM, 2003) and Argentina (Item Codes 1, 2005) for powder milk. The powder samples almost had the same ash content, which was found lower than the standards of Sudan (SSMO, 1999) and USA (FDSPM, 2003), but agreed with that reported by Eckles (2001). Protein and fat contents of the local milk powders were similar and in line with the specified standards of Sudan, USA and Argentina (SSMO, 1999; FDSPM, 2003; Item Codes 1, 2005). A significantly higher lactose content in the composition of the locally packed milk powders than in the imported milk powder (Nido) was noticed. These results agreed with the standards of Sudan (SSMO, 1999) and USA (FDSPM, 2003).

pH, acidity and solubility: Table 2, presents the physical properties of the milk powders. Results reveled that Lodo milk powder (local) had the lowest acidity (1.34%) and the highest pH (6.80) almost similar to the control (Nido). The other local milk powders (Kapo, Foremost, Almarrai and Alprince) showed significant higher acidity ranged between 1.40-1.49%, simultaneously with a pH range of 6.60-6.70. The result are in coincidence with the standards of USA (FDSPM, 2003) and Argentina (Item Codes 1, 2005). The US Dairy Export Council reported that changes in pH do not appear to be significant for a milk powder user at the commercial level (USDEC, 2001). Result indicated that Nido and Foremost were instantly soluble in water (Table 3), comparable to the standards in USA (FDSPM, 2003) and Argentina (Item Codes 1, 2005). The other milk powders are partially soluble in water. The solubility of milk powders depends upon a number of factors such as the amount of dissolved minerals, “hardness”, in the water used, speed and duration of stirring and temperature and other factors (USDEC, 2001).

Microbiological and sensory evaluation: Compared to the count of bacteria in Nido (3×10), the bacterial populations in the all local milk powder samples were almost the same (3×10^{2} to 3×10^{3}) (Table 3). Results, however, notified that the viable bacteria in the milk powders fall within the standard zone specified by Sudan (SSMO, 1999). Additionally, all the samples were found free from *Coliform* sp., thus considered microbiologically safe. Milk powder is generally

Table 1: Nutrient composition of milk powders

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Lactose (%)
Kapo	2.40± 0.03^{a}	27.00±0.12^{a}	27.00±0.03^{b}	5.70±0.01^{a}	38.18±0.05^{b}
Al-marrai	2.31±0.03^{bc}	27.01±0.08^{a}	27.07±0.21^{b}	5.70±0.03^{a}	38.16±0.06^{b}
Foremost	2.23±0.03^{d}	27.07±0.14^{a}	27.03±0.06^{b}	5.70±0.02^{a}	38.16±0.15^{b}
Al-prince	2.06±0.05^{e}	27.05±0.22^{a}	27.00±0.09^{b}	5.70±0.02^{a}	38.16±0.10^{b}
Lodo	2.36±0.01^{ab}	27.10±0.27^{a}	27.00±0.09^{b}	5.70±0.04^{a}	38.98±0.12^{b}
Nido	2.25±0.05^{cd}	27.00±0.17^{a}	28.03±0.12^{b}	5.70±0.04^{a}	37.15±0.05^{b}
Standards					
Sudan	< 3.0%	< 27.0%	< 28%	<7.3%	< 34.0%
USA	< 5.0%	< 28.0%	26.5%	< 6.0%	35.5%
Argentina	< 4.0%	na	< 40%	na	na

*Means of triplicate samples ±SD. Means having different superscripts within the column are significantly different at $p \leq 0.05$. na, not available

Table 2: Physical quality of milk powders

Sample*	pH	Titratable acidity (%)	Solubility
Kapo	6.60±0.10^{b}	1.40±0.03^{bc}	Partially soluble
Al-marrai	6.60±0.10^{b}	1.44±0.05^{ab}	Partially soluble
Foremost	6.70±0.01^{ab}	1.49±0.04^{a}	Instantly soluble
Al-prince	6.80±0.08^{a}	1.34±0.05^{d}	Partially soluble
Lodo	6.60±0.01^{b}	1.41±0.02^{b}	Partially soluble
Nido	6.80±0.10^{a}	1.35±0.02^{cd}	Instantly soluble
Standards			
Sudan	6.6-6.8	na	na
USA	6.6-6.8	< 1.5%	Instantly soluble
Argentina	6.6-6.8	<1.5%	Instantly soluble

*Means of triplicate samples±SD. Means having different superscripts within the column are significantly different at $p \leq 0.05$. na, not available

Table 3: Microbiological and sensory quality of milk powders

	Viable count*		Sensory evaluation	
Sample	Bacteria (cfu/g)	Coliforms (mpn)	Scores (Out of 10)	Quality grade
Kapo	3×10^{2}	Nil	6.9	Fair
Al-marrai	3×10^{3}	Nil	6.9	Fair
Foremost	3×10^{3}	Nil	9.0	Good
Al-prince	3×10^{3}	Nil	6.6	Fair
Lodo	3×10^{3}	Nil	6.3	Fair
Nido	3×10	Nil	9.5	Good
Sudan standard	5×10^{4}			

*Means of duplicate samples

considered a product of good microbiological quality (Fernandes de Oliveira *et al*., 2000), considering that it made from good quality milk and containing low microbial count and the moisture content is kept low (USDEC, 2001).

Nido and Foremost milk powders showed the highest scores for the organoleptic tests (9.5 and 9.0, respectively), while Kapo and Al-marrai gave score of 6.9. Alprince and Lodo gave scores of 6.6 and 6.3, respectively (Table 3). However, the overall sensory tests the samples subjected to indicated that both Nido and Foremost had good quality and the other samples had fair quality.

Conclusion: Results showed that milk powders packed in Sudan were in consistence with the international standards from standpoint of composition and microbiological safety. Nevertheless, they were almost inferior in sensory quality and solubility.

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