Evaluation of some physicochemical parameters of three commercial milk products

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ABSTRACT

The aim of this investigation was to evaluate fresh, whole powdered and infant milk formula on the basis of physicochemical characteristics and heavy metals contents. All samples were collected from local market then analyzed to know the chemical (pH, acidity, fat, protein, lactose, ash, moisture, solids-not-fat, Lead and Cadmium) characteristics. Moisture, ash, protein and fat content for all samples ranged 1.96–86.8%, 0.5–6%, 3.34–25.5% and 3.73–26.3%, respectively. The composition and physico-chemical properties of three commercial milk samples on titratable acidity, density and solids-not-fat (SNF) have been presented. However, titratable acidity content in whole powdered milk was higher 1.51 ± 0.22% than fresh cow's milk (0.31 ± 0.18%) and infant milk 0.77 ± 0.14%. The density almost similar in fresh cow’s milk 1.02 ± 0.00, whole powdered milk 1.03 ± 0.05 and infant milk 1.02 ± 0.02. while solids-not-fat (SNF) ranged from 9 ±1.50 to 91 ± 0.29. Most of composition was found at higher levels in whole powdered milk as compared with fresh cow's milk and infant milk. In this paper the mean Lead level in fresh cow's milk and whole milk powder was 0.6875±0.15 mg/kg and 3.3250±1.66 mg/kg, respectively; while it was 3.64375 ± 1.79 mg/kg in the infant milk. The Cadmium level was 1.9750±0.40, 4.0625±1.9 and 2.1125±0.56 mg/kg in fresh, whole powder and infant milk respectively.

Key words: Fresh milk, whole milk, infant milk, Lead, cadmium, chemical compositions

INTRODUCTION

Milk is considered as a nearly complete food since it is a good source of protein, fat and major minerals. Also, milk and milk products are main constituents of the daily diet, especially for vulnerable groups such as infants school age children and old age (Davies, 1986). Several studies have reported the distribution and occurrence of the essential components in various animal milks (Kholif et al., 1994). Milk and milk products are the most diversified of the natural foodstuffs in terms of composition; contains more than twenty different trace elements including copper, zinc, manganese and iron (Somer, 1974). These metals are cofactors in many enzymes and play an important role in many physiological functions in the human and animal body. Lack of these metals causes disturbances and pathological conditions (Schuhmache et al., 1991). Cow’s milk and milk products have played an important role in the human nutrition. Fresh cow milk is reported to contain about 88% water (Kataoka et al., 1991).

Environment pollution with metals, such as lead, is a world-wide problem. Lead alkyl additives in petrol are combusted and emitted into the atmosphere and can be responsible for high lead concentration in some vegetation along the roads, soil, and air, water (Burguera et al., 1988). Manufacturing processes, waste incineration and coal combustion are also contributing to lead pollution of the atmosphere; hence it is not surprising that areas of intense industrialization have highest lead levels (Shakour et al., 2006). Lead is toxic to the blood and the nervous, urinary, gastric and genital systems. Furthermore, it is also implicated in causing carcinogenesis, mutagenesis and teratogenesis in experimental animals (Pitot and Dragan, 1996; Correia and Oliveira, 2000). On the other hand, cadmium is also easily volatilized at the operating temperatures.
of common industrial processes; much of the cadmium in the atmosphere results from the incineration of ferrous scrap and metallurgic processes (Thomas et al., 1972). Cadmium is considered to be one of the most toxic metals. In addition, it is implicated in high blood pressure (Perry et al., 1979)

Dry milk or powder milk is a product obtained by the removal of water and fat from whole milk. Usually, fat percent for whole milk powder and partially skimmed milk powder range 26% - 40% and 1.5% - 2.5%, respectively. For all types of milk powder, water content ranges from 3-5% (Edgar, 1995). Under any circumstances, water content of dry milk should not exceed 5%. The removal of water from the milk takes place in two stages. The first stage is concentration by vacuum evaporation and the second stage is drying. Ninety percent of the water in the milk is removed in the evaporator and only ten percent in the spray dryer (Robinson, 1994). Powder milk (whole and non fat) are used in manufacturing ice cream, infant foods, bakery goods, confections and sausages and they are utilized by flour millers, and cheese processors. In Bangladesh whole milk and half-cream powder milk available in tin containers are mainly used as baby food. These are also used for convalescents and in the preparation of many other sweetmeats (Kajal et al., 2012). The aim of this investigation was to evaluate fresh, whole powdered and infant milk formula on the basis of chemical composition. Therefore, our study assesses the concentrations of heavy metals present in the milk samples.

**MATERIALS AND METHODS**

Cow’s milk (fresh) and milk whole powder for human consumption, were purchased at health food markets in Omdurman (Sudan); infant milk was purchased at pharmacy in Omdurman (sudan), during January–March 2010.

**Heavy Metal Standards**

Standard solutions of heavy metals i.e., lead (Pb), cadmium (Cd) were provided, in 1000 ppm solution for each one, by Merck (Merck, Darmstadt, Germany). The reagents were from Sigma Chemical Co.

**Analysis of milk**

**Physicochemical analysis:**

The moisture, ash and density were determined according to AOAC (2005). To determine fat, total nitrogen (T.N), lactose, titratable acidity and solids not fat (SNF) contents by Milk-O-Scan as described by Marques and Belo (2001b).

**Heavy metals content**

Heavy metals were extracted from the samples according to AOAC method (AOAC, 2005). The heavy metals were measured by Atomic Absorption Spectrophotometer (AAS) (Perkin Elmer 2380). All glassware, were washed, before use, with distilled water, soaked in nitric acid (30%), then rinsed in redistilled water and air dried. The glassware kept in clean place, to avoid contamination.

**Statistical analysis**

The experiments were conducted at least in triplicate. Analysis of variance (ANOVA) was performed and significant difference in mean values were evaluated by Fisher LSD test at (P<0.05) using SPSS version 19.0 (SPSS, Chicago, IL, USA).

**RESULTS AND DISCUSSION**

**Proximate analysis of milk**

The proximate chemical compositions of milk samples are shown in Table 1. The results exhibited moisture content of 86.8% for fresh milk while ash was 0.5%. On the other hand, the study shows 3.34% of protein content and 4.51 of lactose. The fresh milk contained 3.73 % fat. Whole Powder milk resulted in moisture, ash, protein, lactose and fat of 4.06, 6.0, 25.5, 38.7, and 26.3%, respectively. Whereas, infant milk showed moisture, ash, protein, lactose and fat content of 1.96, 3.0, 14.8, 6.62, and 11.8%, respectively, (Table 1).

The results obtained by the chemical analysis of samples revealed that liquid milk have higher moisture content than the previously values reported by Mishra et al., 2008, this could be due to local sun shining capacity. The ash content value of fresh milk was found lower than the value reported (0.65%) by Enb et al. 2009. Moreover, our study have shown that the protein content were slightly high whereas, the fat content value corroborated with the report of Laura et al.,2009, and higher than the value found by Enb et al., 2009. Results of moisture, protein, and fat content were significantly different (P ≤ 0.05) among the three samples of milk (Table 1). The fat content in whole milk powder tended to be higher that of fresh and infant formula milk, indicating that the three milk samples had significantly different fat content.

**Physicochemical analysis**

The physical characteristics such as solids not fat (SNF), density and titratable acidity are important parameters in studying the physicochemical composition and nutritional aspects of milk. The results of the densities of all milk’s samples were similar and within the required range of 1.02 to 1.03 g/cm3. The solids not fat content (SNF) of fresh milk (9%) was lower as compared to those of whole powder milk (72.7%) and infant milk (91%).
The titratable acidity ranged from 0.31%-1.51%. It was observed that the average value of SNF obtained from whole powder milk (72.7±0.31) was significantly lower than the SNF of infant milk sample (Table 3). (Kumar and Murthy,1992) found that the average SNF content of fresh whole milk powder from three batches were 96.27, 97.38, 96.97 g/100g. Solids-not-fat (SNF) content ranged from 10.64 to 13.41%, whereas fresh cow milk sample recorded below the SNF minimum of 9% (Case et al., 1981; SANS, 2006). Density or specific gravity of the raw milk ranged from 1.029 to 1.033 which was within the SA regulated minimum standard (SABS) of 1.028.

**Heavy Metals**

The results in Table (3) shows that whole milk powder, children dry milk and cow milk have Pb concentration of 3.3250, 3.64375 mg/kg and 0.6875 mg/kg, respectively. Present work showed that the mean Cd level for whole milk powder, children dry milk and cow milk was 4.0625, 2.1125 and 1.9750mg/kg, respectively. The high level of Pb in cow’s milk may be due to the use of pesticides on cattle fodder. Rodriguez et al. found that the concentrations of Cd and Pb in cow milk varied according to the time of year. The mean concentration of heavy metals were compared with the mean levels of heavy metals detected in raw milk samples, collected from Cairo during the period of 1988 to 1990, in the previous studies (Abou-Arab 1991). The results revealed that metals concentrations in our samples were comparatively higher than in the earlier research. The author reported that Pb and Cd were 0.05 and 0.348 mg/kg, respectively. Results also revealed that, levels of metals under study were higher than levels recorded by Koops et al., 1988 ; Debeka and McKenzie, 1987). High levels of heavy metals in this study may be attributed to the high contamination of animal feed and water by such pollutants and could be excreted into milk at various levels. Concentration of lead and cadmium in whole milk powder and children dry milk samples were higher than the acceptable limits. However, the concentration of the heavy metals in fresh cow milk sample was lower than the highest acceptable limits. These results suggested that control is necessary to avoid heavy metal contamination of primary food products the for enhanced food safety.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Lactose (%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Milk</td>
<td>86.8 ± 0.24a</td>
<td>3.34 ± 0.37a</td>
<td>3.73 ± 0.29a</td>
<td>4.51 ± 1.04a</td>
<td>0.5 ± 0.14a</td>
</tr>
<tr>
<td>Whole Milk Powder</td>
<td>4.06 ± 0.29b</td>
<td>25.5 ± 0.65b</td>
<td>26.3 ± 0.60b</td>
<td>38.7 ± 0.78b</td>
<td>6.0 ± 0.26b</td>
</tr>
<tr>
<td>Infant Milk</td>
<td>1.96 ± 0.27c</td>
<td>14.8 ± 1.50c</td>
<td>11.8 ± 1.80c</td>
<td>6.62 ± 0.10c</td>
<td>3.0 ± 0.13c</td>
</tr>
</tbody>
</table>

Values are means of at least three measurements ± standard deviation. Mean values in the same raw with different letters are significantly different (P ≤ 0.05)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Acidity (%)</th>
<th>Density(g/cm^3)</th>
<th>Solids-not-fat (SNF) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Milk</td>
<td>0.31 ± 0.18a</td>
<td>1.02 ± 0.00a</td>
<td>9 ±1.50a</td>
</tr>
<tr>
<td>Whole Milk Powder</td>
<td>1.51 ± 0.22b</td>
<td>1.03 ± 0.05b</td>
<td>72.7 ± 0.31b</td>
</tr>
<tr>
<td>Infant Milk</td>
<td>0.77 ± 0.14a</td>
<td>1.02 ± 0.02a</td>
<td>91 ± 0.29a</td>
</tr>
</tbody>
</table>

Values are means of at least three measurements ± standard deviation. Mean values in the same raw with different letters are significantly different (P ≤ 0.05)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pb (mg/kg)</th>
<th>Cd (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Milk</td>
<td>0.6875 ± 0.15</td>
<td>1.9750 ± 0.4</td>
</tr>
<tr>
<td>Whole Milk Powder</td>
<td>3.3250 ± 1.66</td>
<td>4.0625 ± 1.9</td>
</tr>
<tr>
<td>Infant Milk</td>
<td>3.64375 ± 1.79</td>
<td>2.1125 ± 0.56</td>
</tr>
</tbody>
</table>

*Values are means of triplicate tests.*
CONCLUSION
Milk is a rich source of major and minor components which are essential to provide the nutritional requirements to human body. However, some commercial milk products contain comparatively higher concentrations of heavy metals. It suggests that the technology and quality control for milk processing should be improved and environmental pollution should be controlled.

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