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Short Communication

Mineral profiles of powdered milk, yoghurt, ice cream and raw milk

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Abstract: The present study was undertaken to update the dairy food composition database of Bangladesh by studying the minerals profile of important milk and milk products. Major minerals such as Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg) and Phosphorus (P) contents of powdered milk, yoghurt, ice cream and raw milk of cows were investigated in this study. The research was conducted at the postgraduate laboratory of Dept. of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh. Na and K content were found by flame spectrophotometry method, Ca and Mg by EDTA titrimetric method and P by UV-visible spectrophotometric determination. One Way ANOVA (with 'p' values) was done by using statistical analytical software Stata 12. ANOVA was coupled with Tukey's test that gives mean separation in case of significant difference among the samples. Concerning mean values, powdered milk contained the highest Na (3138.19 ppm), K (9394.47 ppm), Ca (7615.2 ppm), Mg (891.18 ppm) and P (11332.36 ppm), whereas, the lowest Na (93.09 ppm), K (463.39 ppm) and Ca (1362.72 ppm) were found in raw milk and the lowest Mg (267.35 ppm) and P (1673.99) were found in ice cream. Elemental composition varied significantly from product to product ($p<0.05$). From this study it could be concluded that major minerals are found highest in powdered milk and lowest in raw milk, whereas, yoghurt and ice cream contained intermediate level of minerals.

Keywords: mineral profile; powdered milk; yoghurt; ice cream; raw milk

1. Introduction

Mineral elements account for 4% of total body mass and part of every tissue, liquid, cell and organ in human body. There is a sufficient evidence that minerals, both independently or in proper balance with other minerals, have structural, biochemical and nutritional functions that are very important for overall human health, both mental and physical (Vahčić *et al*., 2010).

Milk and dairy products are important sources of dietary minerals. The mineral content especially sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and phosphorus (P) in milk has a physiological significance in infant nutrition. Also, calcium and phosphorus constitute a larger fraction in milk which is needed for bone growth and the proper development of newborns. Milk and dairy products supply three of the five minerals (Mg, Ca, K) that were identified as those most needed in children's diet (US Department of Agriculture, 2005). The requirement of these minerals is difficult to reach without consuming milk and dairy products. Conversely, excessive intake of mineral elements may cause clinical problems because they can start accumulating, limiting the renal capacity (Cashman, 2002a). So, we need to know the mineral profile of our food items to optimize our daily intake. People of Bangladesh consume whole milk, imported powdered milk, traditionally yoghurt and ice cream all over the country. Data of mineral profiles of milk and dairy products are available for other countries but not available for Bangladesh. However, it should be emphasized that there are insufficient researches on the content and chemical form of minerals in milk and dairy products. (Zamberlin *et al.*, 2012). To the best of my

knowledge, Islam *et al*. (2014) described the mineral profile of cows and buffalo milk, but still need more information about the other dairy products. That's why the objective of present study is to know the content of major mineral profile of powdered milk, yoghurt, ice cream and raw fluid milk of cow's to update dairy food composition database in Bangladesh.

2. Materials and Methods

2.1. Study area and duration

The research work was conducted at the postgraduate laboratory of Agricultural Chemistry, Bangladesh Agricultural University**,** Mymensingh, during the period from 21th September, 2015 to 30th October, 2015.

2.2. Collection of samples

Sample products were collected from different local shops at BAU, Mymensingh-2202. These products were analyzed in the laboratory during the experimental period.

2.3. Digestion of the samples

For digestion of the samples in a 10 ml diacid mixture of concentrated HNO_3 and concentrated $HClO_4$ (2:1), 1g sample was taken from each sample products. Then, they were set in 'heating digester' at 180°C for 1 hour. After 1 hour only powdered milk samples were undigested and a thin film of white plastic type layer was seen there. According to the setup of the machine, the powdered milk samples were digested with extra 10 ml added diacid mixture at 350°C for another 1 hour. Then after cooling, dilution factor was calculated.

2.4. Test of major ionic or mineral constituents

2.4.1. Sodium and Potassium

Jenway flame photometer (Indonetwork, model PFP7, United Kingdom) was used to determine potassium and sodium contents from the sample extracts separately using potassium and sodium filters. The sample extracts were aspirated into a flame and the intensity of light emitted by K at 768 nm or Na at 589 nm wavelength was directly proportional to the concentration of K or Na, respectively present in the sample extracts. The percent of emission was recorded following the method as outlined by Ghosh *et al*. (1983).

2.4.2. Calcium

Calcium was determined from the sample extracts by EDTA titrimetric method using Na_2EDTA as a chelating agent (Page *et al*., 1982; Singh *et al*., 1999). For Ca determination, 10 ml sample extract was taken in 250 ml conical flask followed by the addition of 25 ml distilled water and 5 ml of 10% NaOH solution (pH 12). After shaking thoroughly, each of 10 drops of hydroxylamine hydrochloride ($NH_2OH.HCl$), potassium ferrocyanide ($K_2[Fe(CN)_6].3H2O$) and triethanol amine ($C_6H_{16}NO_3$) were added subsequently as masking agents and 5-6 drops of calcon ($C_{20}H_{13}N_2NaO_5S$) was used as indicator. The sample extract was then titrated against Na_2 EDTA (0.01 M) solution from a burette until pink color turned to pure blue color.

2.4.3. Magnesium

Magnesium of dairy products (powdered milk, yoghurt, ice cream and milk) was determined by EDTA titrimetric method using Na_2EDTA as a complexing agent at pH 10 in presence of Eriochrome Black T (EBT) indicator (Page *et al*., 1982; Singh *et al*., 1999). Exactly 10 ml sample extract was taken in 250 ml conical flask followed by the addition of 25 ml distilled water, 5 ml NH_3-NH_4 buffer solution and 10 drops each of masking agents like sodium tungstate, hydroxylamine hydrochloride, potassium ferrocyanide, triethanolamine (TEA). After the addition of eriochrome black T (EBT) indicator, the sample was titrated against standard Na_2 EDTA (0.01 M) solution from a burette until pink color completely turned to pure blue color.

2.4.4. Phosphorus

Phosphorus of the sample extracts was determined colorimetrically by stannous chloride ($SnCl_2$) method according to the procedure outlined by Jackson (1973) and Tandon (1995). In this method, stannous chloride ($SnCl_2.2H_2O$) was used as a reducing agent which formed molybdophosphoric blue complex with sulphomolybdic acid. Exactly, 1 ml sample extract was taken in a 100 ml volumetric flask followed by the addition of 4 ml sulphomolybdic acid and 4-6 drops of stannous chloride ($SnCl_2.2H_2O$) solution. The color intensity was measured at 660 nm wavelength with the help of a T60 UV-Visible spectrophotometer (PG instruments Limited, Model T60U, China) within 10 to 15 minutes after the addition of stannous chloride.

2.5. Statistical analysis

Data were analyzed statistically by one way analysis of variance (ANOVA). ANOVA (with 'p' values) was done by using statistical analytical software Stata 12. Moreover, ANOVA was coupled with Tukey's test that gives mean separation in case of significant difference among the samples.

3. Results and Discussion

Results showed that, major mineral contents of powdered milk, yoghurt, ice cream and raw milk varied significantly from product to product ($p<0.05$) which is shown in Table 1. Powdered milk contained the highest Na (3138.19±37.91 ppm), K (9394.47±49.53 ppm), Ca (7615.2±400.8 ppm), Mg (891.18±140.32 ppm) and P (11332.36±141.20ppm), whereas, the lowest Na (93.09±24.82ppm), K (463.39±37.83ppm) and Ca (1362.72±212.08) were found in raw milk and the lowest Mg (267.35±42.09ppm) and P (1673.99±59.17 ppm) were found in ice cream.

In this study, mineral contents found in powdered milk for Na (3138.19±37.91), K(9394.47±49.53), Ca(7615.2±400.8), Mg (891.18±140.32) and P (11332.36±141.20); whereas, E.O. Akpanyung (2006) found mineral contents for powdered milk (in mg/100g) for Na (7.54±0.12),K (1710±32),Ca (1110±2.00),Mg (110±0.08),P (690±3.20), respectively. If units of measurements are alike, even after that, there are huge differences in results.

Table 1. Major mineral contents (ppm)[1] of milk and dairy products tested for different brands available in Bangladesh.

Name of the product	Na (Mean±SD)	K (Mean±SD)	Ca (Mean±SD)	Mg (Mean±SD)	P (Mean±SD)
Powdered milk	3138.19^{a} ± 37.91	9394.47^{a} ± 49.53	7615.2^{a} ± 400.8	891.18^{a} ± 140.32	11332.36^{a} ± 141.20
Yoghurt	928.84^{b} ± 14.33	1759.31^{b} ± 37.83	2177.68^{b} ± 205.67	648.13^{ab} ± 280.65	2747.68^{b} ± 94.13
Ice cream	581.30^{c} ± 37.92	1280.56^{c} ± 14.30	1803.6^{bc} ± 200.4	267.35^{b} ± 42.09	1673.99^{c} ± 59.17
Raw milk	93.09^{d} ± 24.82	463.39^{d} ± 37.83	1362.72^{c} ± 212.08	502.30^{ab} ± 28.06	1869.204^{c} ± 80.64
LS	**	**	**	**	**

ppm, parts per million; [1]Values represent the mean of triplicate determinations ± SD for each sample; LS, Level of significance; **, significant at at 1% ; ^{a,b,c,d}means with different subscriptions in a same column differs significantly.

Values obtained for yoghurt minerals (in ppm) were Na (928.84±14.33),K (1759.31±37.83), Ca (2177.68±205.67), Mg (648.13±280.65) and P (2747.68±94.13).According to Chibane *et al*. (2011), the natural yoghurt values obtained were (in mg/kg; where, 1mg/kg=1ppm): Na (684.72), K (540.58), Ca (1950.41), Mg (132.16). Chibane *et al*. (2011) did not go through the results for P.

Mineral contents of ice cream minerals were (in ppm): Na (581.30±37.92), K(1280.56±14.30), Ca(1803.6±200.4), Mg(267.35±42.09) and P (1673.99±59.17) which are similar to the values found by a very recently published study by Yangilar (2015). Five major minerals in ice cream for the control group were (in mg/kg; because 1ppm=1mg/kg) Na (537.68±6.37), K (1669.56±21.20), Ca (1844.36±12.72), Mg (159.31±1.39) and P (1100.86±0.01) respective Mineral contents found for raw milk (in ppm) were, Na (93.09±24.82), K (463.39±37.83), Ca (1362.72±212.08), Mg (502.30±28.06), P (1869.204±80.64) where Islam *et al*. (2014) found indigenous cattle milk minerals (g/kg) such as- Na (0.40±0.00), K (1.61±0.00), Mg (0.12±0.00), Ca (1.32±0.01) and P(1.08±0.00) respectively.

Na, K, Ca, Mg and P found in yoghurt and ice cream were of similar results as Chibane *et al*. (2011) and Yangilar (2015). However, results found for minerals of powdered milk and raw milk contradicted with the results of E.O. Akpanyung (2006) and Islam *et al*. (2014).

4. Conclusions

In this study, major minerals of powdered milk, yoghurt, ice cream and raw milk (of cows) were quantified and compared. Essential mineral elements, including sodium, potassium, calcium, magnesium and phosphorus were

found in all milk types and dairy products but they varied significantly from one product to another. The collected data was tabulated very carefully and analyzed statistically with STATA software version 12.0.

Among the aforementioned milk and milk products, all the obtained mineral elements found more in powdered milk than in raw milk. However, minerals in other products such as-yoghurt and ice cream were in normal range.

As this is a recent research topic in Bangladesh, this study creates a new avenue to determine the mineral profiles in milk and dairy products. Therefore, it could be applicable to formulate balanced human diet for proper growth and development.

Although the subject is very important, there is a lack of theses, recently published papers and articles which are dealing with individual minerals in milk and dairy products. This study, therefore, would recommend the need for further study of other individual minerals in other dairy products in Bangladesh as well as other countries.

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Conflict of interest

None to declare.

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