The Effect of Water Type and Reconstitution Temperature on the Solubility of Commercially Available Milk Powders in Sri Lanka

W. V. V. R. Weerasingha[1], M. Gunawardena[2] and J.K. Vidanarachchi*

***,[1]Department of Animal Science, Faculty of Agriculture, University of Peradeniya, [2]Sri Lanka Institute of Nanotechnology, Homagama, Sri Lanka.**

wvvirajroshan7@gmail.com janakvid@pdn.ac.lk.

Abstract

The objective of this study was to investigate the effect of water type and water temperature levels on the solubility of commercially available milk powders in Sri Lanka. In addition to that, chemical properties of milk powders were analyzed and compared with international quality standards. Solubility was measured using insolubility index method and three water types were used including distilled water, deionized water and nano-water at two different temperature levels as 24 °C and 80 °C. Altogether 30 milk powder samples were tested including two locally produced and four imported milk powder brands. According to the insolubility index values, imported milk powder brands possessed higher solubility (0.49±0.05) than the locally produced ones (0.82±0.03) in all the three water types and temperature levels. When comparing the three different water types, solubility of milk powders were significantly lower ($p<0.05$) in de-ionized water, compared to nano-water and distilled water at 24 °C temperature in both imported and local milk powders. At 80 °C temperature level, imported milk powder brands showed a lower solubility in de-ionized water while local milk powder brands showed significantly lower solubility ($p<0.05$) in nano-water. All the milk powders had much higher solubility at 80 °C when compared to that of 24 °C. Present study results revealed that Free Fatty Acid levels in imported milk powders exist within the acceptable range (1.57±0.5 mmol/100 g fat) while it is much higher than acceptable limits in locally produced milk powders (4.43±0.1 mmol/100 g fat). All the other chemical properties including fat, protein, ash, Ca, pH, moisture and water activity were within the acceptable standard levels in both local and imported milk powders and it can be concluded

that compositional changes of milk powders also affect on the solubility other than water type and temperature levels during reconstitution.

Keywords: Free fatty acids, Insolubility index, Nano water, Solubility.

Introduction and research problem/issue

Milk powder is produced by evaporation of water from liquid milk to dryness. Major purposes of milk powder production are preservation of liquid milk and to obtain a prolonged shelf life while

little or no detrimental changes compared to original liquid milk. Milk powders possess various physical and instant properties which are important to both industry and consumer.

Since solubility of milk powder is concerned as one of the major quality attributes, low soluble powders have limited usage and it is considered as a quality defect. Solubility indicates the degree of scorched particle, protein denaturation and status of protein in the milk powder. During dissolution, a sediment layer can be formed in the bottom due to the lower solubility of powders. Therefore, insolubility may affect processing difficulties and economic losses. And also it may negatively affect other functional properties of milk powders such as emulsification, gelation, foaming and whipping properties.

Consumers generally determine the quality of milk powders by using colour, taste and more importantly considering the solubility of milk powders. Therefore analysis of milk powder composition and external factors affecting solubility provides fair evidences with regard to the betterment of consumption and improved solubility properties of milk powders. The objective of this research was to determine the impact of type of solvent and solvent temperature during reconstitution on the solubility of commercially available milk powders.

Research Methodology

Experiment was performed using most commonly available four imported milk powder brands and two locally produced milk powder brands in Sri Lankan market. Thirty milk powder sachets as five biological replicates from each brand which have same packed date were collected from supermarkets in the Kandy city.

Solubility Test, Moisture Content, pH

Solubility was measured by insolubility index method which is described by IDF 129 | ISO 8156 (2005). Solubility of each available brand was determined using distilled water, deionized water and nano-water at 24°C and 80°C temperature levels.

Moisture determination was done by routine method as described in IS 16072 (2012) and pH determination was carried out using a pH meter (Model: 775249 Eutech, Singapore).

Determination of Protein, Fat, Ash, Ca and Free Fatty Acid (FFA) contents

Protein, Fat, Ash and Ca content determinations were carried out according to the AOAC (2005) procedure. Free fatty acid content of milk powder samples was determined using extraction titration method.

4. Results and findings

Table 01**:** Chemical properties of whole milk powders available in Sri Lanka (all values are presented as the means ± S.D for five replicates analysis)

Milk powder brand	Protein content (%)	Fat content (%)	Moisture content (%)	FFA content (mmol/ 100gfat)	Cacontent (mg/100g)	Ash content (%)	pH
Control	29.4±2.5^{a}	17.1±0.4^{d}	1.02±0.2^{c}	2.47±0.30^{b}	736.3±135^{a}	6.70±0.4^{a}	7.06±0.13^{a}
Brand A	23.6±0.4^{d}	29.3±1.9^{a}	2.54±0.6^{ab}	1.62±0.09^{bc}	424.6±047^{c}	5.60±0.6^{c}	6.88±0.09^{ab}
Brand B	23.7±0.5^{d}	26.6±1.0^{ab}	3.10±1.0^{a}	1.17±0.22^{c}	471.3±031^{bc}	5.25±0.2^{c}	6.74±0.27^{bc}
Brand C	20.3±0.9^{e}	23.3±1.3^{c}	2.00±1.1^{abc}	2.28±0.33^{b}	445.7±062^{bc}	4.05±0.3^{d}	6.74±0.28^{bc}
Brand D	24.3±0.3^{cd}	26.6±1.8^{b}	2.70±1.0^{ab}	1.20±0.30^{c}	477.1±040^{bc}	5.55±0.3^{c}	6.56±0.24^{c}
Brand E	26.4±1.6^{b}	26.3±1.6^{b}	1.73±0.9^{bc}	4.45±0.89^{e}	567.8±095^{b}	6.28±0.5^{b}	6.91±0.18^{ab}
Brand F	25.6±1.0^{bc}	23.6±1.2^{c}	2.50±0.8^{ab}	4.42±0.79^{e}	497.3±101^{bc}	5.64±0.2^{c}	7.04±0.17^{a}

Column mean value with different superscript letters are significantly different at ($p<0.05$).

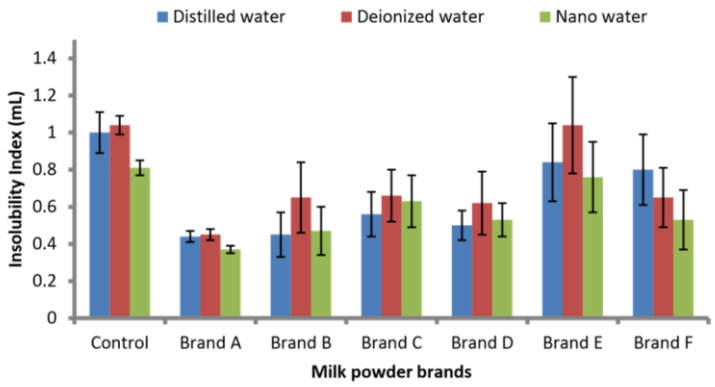

Figure 01: Insolubility index variation in milk powder brands with different kinds of water types when milk powder reconstituted at 24°C

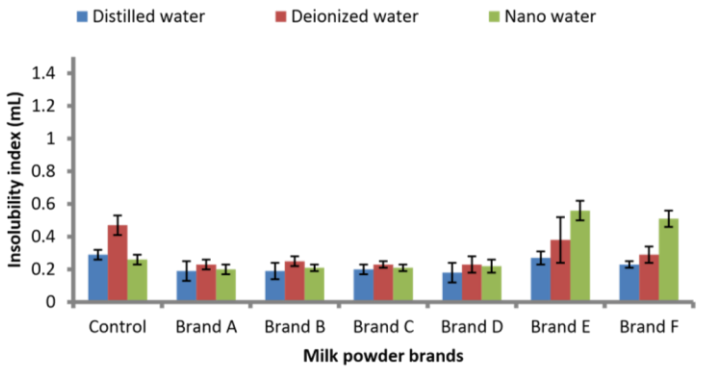

Figure 02: Insolubility index variation in milk powder brands with different kinds of water types when milk powder reconstituted at 80°C

As shown in Fig. 01 and Fig. 02, insolubility index of all the milk powder brands have reduced when the reconstitution temperature is increased. It is clear that, all the imported and local milk powder brands showed higher insolubility index value with deionized water at 24 °C temperature. At 80 °C imported milk powders had higher insolubility index values with deionized water while local milk powder brands had significantly higher insolubility index with nano-water. This clearly implies that, temperature of the solvent affect on the solubility of milk powders. Perhaps high insolubility with deionized water could be due to less formation of hydrophilic bonds between water molecules and powder proteins. Previous studies have proved that combination of solvent type and reconstitution temperature could effect on the solubility of milk protein concentrates. Present study results also in agreement with those findings. Statistical analysis revealed that there is a significant impact of milk powder brand, water type and temperature level, on the solubility ($p<0.05$) properties and degree of impact is higher in temperature level and milk powder brand compared to other interaction effects. All the other chemical properties analyzed were within the acceptable standard levels except the Free Fatty Acids. Local milk powder brands contain much higher Free Fatty Acid content while imported brands contain acceptable level of Free Fatty Acids suggesting compositional differences among local and imported brands.

Conclusions, implications and significance

Both solvent type and reconstitution temperature affect the solubility of milk powders while local and imported milk powder brands have different solubility patterns in different solvent types and temperature levels. In almost all cases, milk powder samples reconstituted at 80 °C were significantly more soluble than the same samples reconstituted at 24 °C.

6. References (Selected)

Mcsweeney, P. L. & O'Mahony, J. A. 2015. Advanced Dairy Chemistry: Volume 1B: Proteins: Applied Aspects, Springer.

Sharma, A., Jana, A. H. & Chavan, R. S. (2012). Functionality of Milk Powders and Milk Based Powders for End Use Applications-A Review. *Comprehensive Reviews in Food Science and Food Safety*, 11: 518-528.

Sikand, V., Tong, P. S., Vink, S. & Walker, J. (2012). Effect of powder source and processing conditions on the solubility of milk protein concentrates 80. *Milchwissenschaft*, 67: 300-302. Uddin, G.M. (2011). Characterization of the rehydration behaviour of milk protein concentrates in the presence of sugar. M.Phil Thesis report, Massey University, Manawatu campus, New Zealand.

*Corresponding Author, Tel: 0714430552

E-mail Address: janakvid@pdn.ac.lk