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Research Article

Frequent Supply of Adulterated Milk at Southern Zone of Sindh, Pakistan

Ghulam Shabir Barham[1*], Muhammad Khaskheli[1], Aijaz Ahmed Soomro[2], Zaheer Ahmed Nizamani[3], Atta Hussain Shah[1] and Gul Bahar Khaskheli[1]

[1]*Department of Animal Products Technology, Faculty of Animal Husbandry & Veterinary Sciences, Sindh Agriculture University, Tandojam, Pakistan*

[2]*Institute of Food Sciences and Technology, Faculty of Crop Production, Sindh Agriculture University, Tandojam, Pakistan*

[3]*Department of Veterinary Pathology, Faculty of Animal Husbandry & Veterinary Sciences, Sindh Agriculture University, Tandojam, Pakistan*

Abstract

Most of the milk from production to ultimate consumption in the Sindh province of Pakistan is marketed under traditional pattern, whereby informal channels are directly involved in unethical activities of adulteration in market milk. The emergence of these activities renders the milk unwholesome and inferior in quality that may create health hazards for consumers. In this regard, 300 market milk samples from different milk marketing channels at three urban cities (Karachi, Thatta and Badin) of southern zone of Sindh province were screened for various adulterants. Among all three urban cities of southern zone the extent of water in market milk samples was comparatively (P<0.05) high and with salicylic acid the low, while with detergent at second top followed by with rice flour, cane sugar, starch, caustic soda, sodium chloride, formalin, skimmed milk powder, urea, hydrogen peroxide, vegetable oil, glucose, ammonium sulfate, boric acid, arrowroot, dalda ghee, sorbitol and hypochlorite. The freezing point of milk sampled from retail, middleman and milk collector level at Badin and Thatta was noticed markedly (P<0.05) high towards water compared to milk sampled from Karachi, similarly, the effect of all milk selling mediators mainly retailer, middleman and milk collector in Thatta and Badin cities of southern zone of Sindh was dominant (P<0.05) on water adulteration in milk as compared to processor and producer at Karachi city of southern zone of Sindh, Pakistan.

Keywords: Adulterants; MAT Kit; Milk; Pakistan; Sindh; Southern zone

***Corresponding author:** Ghulam Shabir Barham, Department of Animal Products Technology, Faculty of Animal Husbandry & Veterinary Sciences, Sindh Agriculture University, Tandojam, Pakistan, Tel: +92 03013618136; E-mail: shabir_phd@hotmail.com

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Introduction

Among top five dairy hubs of the globe; after India, USA and China, Pakistan is at 4th position followed by Brazil. The present milk production of the country is 56.080 million tons, though the foremost milk contributors are buffalo and cattle. Country naturally blessed with high yielding buffalo and cattle breeds i.e., Nilli Ravi, Kundhi and Aza Kheli buffaloes and Red Sindhi, Sahiwal cattle which contributes about 95% in total milk production [1].

Within Sindh province of Pakistan milk is consumed as fresh, boiled, powdered and in processed form like tetra pack, yogurt, ghee, lassi, butter, cheese, ice cream, sweets and in other confectioneries [2]. Although, milk is rich in food value and supplies nutrients like good quality proteins, fat, carbohydrates, vitamins and minerals in significant amount than any other single food [3].

Unfortunately in Pakistan its production and distribution systems are still very traditional and underdeveloped. Out of total milk production in the country, only 3-5% of milk is marketed through formal channels and the remaining 95-97% is marketed in raw form by informal agents in the marketing chain. These informal agents are directly involved in the unethical activities of milk adulteration [4].

Milk dealers diluted the milk with extraneous water to increase the volume of milk and/or extraction of valuable component like milk fat in term of cream from whole milk to maximize their profit margin [5]. In this context, thickening agents like starch, rice flour, arrowroot and/or constitutional agents like glucose, cane sugar, sodium salts, urea etc. and/or other adulterants are also used to mask the influence of extraneous water on physico-chemical, nutritional and sensory qualities of adulterated milk. For instance, the detergents are found to be used as emulsifiers and to enhance the cosmetic nature of water diluted milk. Detergents are also act as surfactants which help foreign fat or vegetable oil to blend in water and produce foaming properties in milk to mask the water adulteration [6]. Calcium thioglycolate or Potassium thioglycolate and urea are added for whitening of milk, and to maintain the protein level. Only few grams of urea are sufficient to bring milk in its original state. Urea is also known to be added in milk to enhance its heat stability [7,8]; vegetable oil and/or mobil oil is admixed in milk to increase the fat level. Sodium salt is added to water diluted milk to enhance the ash level and specific gravity.

This intentional approach of addition of inferior substances in milk to extend its shelf life, resulting health hazards as it may contain various pathogens and toxic chemicals. For example, milk may be deteriorated through microbial contamination that is generally a consequence of addition of contaminated water, which may cause highly fatal diseases; Hepatitis, Polio, Tuberculosis etc. [9,10]. Carbonate in

milk may produce gastrointestinal problems including gastric ulcer, diarrhea, colon ulcer and electrolytes disturbance [11]. While, the hydrogen peroxide disturbs the antioxidants in the body and disturbing the natural immunity hence increasing aging [12]. High level of sodium chloride/salt in the milk disturbs the acid base balance and blood pH in the body and the addition of ammonia/urea in the milk may cause regression, loss of acquired immunity, kidney problems and sensory disturbances [13]. Formalin causes vomiting, diarrhea and abdominal pain. It also affects the optic nerves and cause blindness and is one of the potent carcinogens [14]. Boric acid causes nausea, vomiting, diarrhea, kidney damage, acute failure of circulatory system and even death [15]. Benzoic acid produces adverse effects such as asthma, urticaria, metabolic acidosis and convulsions in sensitive persons [16,17]. Moreover, melamine an industrial chemical is also used in the milk adulteration and its contamination in milk causes the urinary tract problems in infants and children [18]. Unfortunately, due to unorganized and non-regulated marketing systems, the milk supplied to consumers is very crucial and hardly be a wholesome in the country [19]. Thus in the present investigation, the study area was scattered on three urban cities of southern zone of Sindh province of Pakistan, which were structured on milk marketing and consumption basis whereby milk samples from different intermediaries involved in milk marketing in each zone were screened for the adulteration.

Materials and Methods

Sample collection

A total of 300 market milk samples, hundred (n=100) from each urban city (Karachi, Thatta and Badin) of Southern zone of Sindh province, Pakistan and sixty (n=60) from each milk intermediary (producer, milk collector, middleman, processor and retailer) were collected. Different milk marketing intermediaries involved in the milk supply business were identified to observe the extent/risk of adulteration within the study area. A volume of 500ml milk sample was collected for each sample from individual milk intermediary. The pattern of milk samples collection is shown in the following chart (Figure 1).

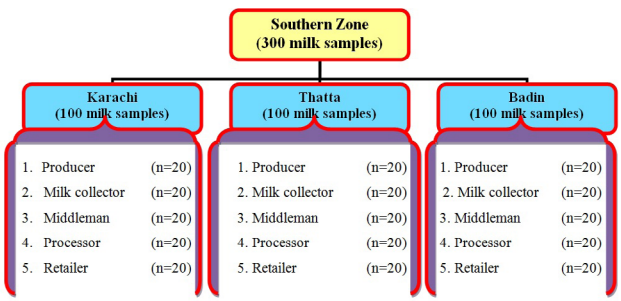

Figure 1: Flow chart showing the pattern of milk sampling from various intermediaries at different urban cites of southern zone of Sindh, Pakistan

All the collected milk samples from different milk marketing intermediaries were screened for various adulterants at the Department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Science, Sindh Agriculture University Tandojam, Pakistan. Among all the collected milk samples every sample was divided in different parts and analyzed individually for the detection of each adulterant.

Detection of extraneous water: Presence of extraneous water in market milk was observed according to the method of Association of Official Analytical Chemists [20]. The depression of freezing points of market milk and authentic milk samples (as freezing point base) was recorded using Cryoscope. The observed values of freezing point of market milk greater than that of authentic sample was assumed as presence of extraneous water in market milk.

Qualitative detection of adulterants

Starch, ammonium sulfate, arrowroot, boric acid, caustic soda, cane sugar, dalda, detergent, formalin, hydrogen peroxide, hypochlorite, NaCl/sodium chloride, rice flour, salicylic acid, skimmed milk powder, sorbitol, urea and vegetable oil in market milk samples were detected using Milk Adulteration Testing (MAT) kit methods as reported by Tipu et al. [21].

Experimental procedure

Market milk sample (1ml) was taken into MAT kit tube and 1ml standard reagent was added to it for the analysis of each adulterant. Development of colour in milk was matched with MAT kit colour chart for each adulterant presumed to be positive (+ve) or negative (-ve).

Other types of adulterants; skimmed milk powder, vegetable oil and dalda ghee in each market milk sample was detected through following analytical approaches.

Detection of Skimmed Milk Powder (SMP*)*

Market milk sample (5ml) was taken into test tube and concentrate nitric acid (10 drops) was added to it. Development of orange colour in milk was presumed to be positive (+ve) and the yellow colour for negative (-ve) for skimmed milk powder adulteration in milk [22].

Detection of vegetable oil

Market milk sample (1ml) was taken into test tube and absolute alcohol (9ml) was added to it. Then it was left to stand for 5 min. floating of fat globules on the top was considered as natural fat of milk, and that which sunk in the bottom was assumed as addition of vegetable oil in the milk sample [22].

Detection of dalda ghee

Market milk sample (3ml) was taken into test tube and 10 drops of hydrochloric acid and one tea spoon of sugar was added to it. It was left for 5 minutes and colour was noted. Development of red colour in milk was presumed as positive (+ve) to dalda ghee [22].

Statistical Analysis

The data was analyzed through statistical procedure of analysis of variance (Factorial ANOVA) to observe the significant differences among the variables and in case of the significant differences appeared among the means; Least Significant Difference (LSD) test at 5% level of probability was applied. In this context the computerized statistical package i.e., Student Edition of Statistix (SXW), Version 8.1 (Copyright 2005, Analytical Software, USA) was approached.

Results and Discussion:

Percent of milk samples deteriorated with various adulterants at Southern zone of Sindh province

During current investigation a wide range of adulterants were detected in the market milk which is consumed at Karachi, Thatta and Badin cities situated at the southern zone of the Sindh province of Pakistan. Results depicted in figure 2 shown that at the southern zone (Karachi, Thatta and Badin) of Sindh province, the deterioration of milk samples collected from various intermediaries (Producer, milk collector, middleman, processor and retailer) with extraneous water (81.33%) was found remarkably ($P<0.05$) higher followed with the adulteration of milk with detergent (32.0%), each of rice flour and cane sugar (24.0%), caustic soda (18.0%), NaCl; sodium chloride (17.0%), starch (14.6%), formalin (6.7%), skimmed milk powder (6.3%), each of hydrogen per oxide and urea (5.0%), ammonium sulfate (4.3%), each of vegetable oil and boric acid (4.0%), each of glucose and arrowroot (3.0%), dalda (2.0%), hypochlorite (1.7%), salicylic acid (1.3%) and sorbitol (1.0%), respectively. Water adulteration in milk might be varied place to place. For instance 100% water added milk samples at Hyderabad, Latifabad, Qasimabad and coastal cities of Pakistan and at Barisal district of Bangladesh [23-26]. 84 and 93.33% water adulterated milk samples were detected by Eman et al. [27], and Lateef et al. [28]. Detergents are surfactants which help foreign fat or vegetable oil to blend in water, and also produce foaming properties in milk to mask the water adulteration. This trend has been supported by Manish et al. [6], and Kandepal et al. [29], they reported excessive use of detergents (20mg) for the preparation of synthetic milk and to emulsify and dissolve the oil in water giving the frothy solution, the characteristic white colour of milk in India. Lateef et al. [28], and Faraz et al. [30], reported 93.33 and 97% samples positive to cane sugar at Punjab province of Pakistan. Eman et al. [27], found 40% milk sample positive for boric acid at Sohag Governorate state of Egypt.

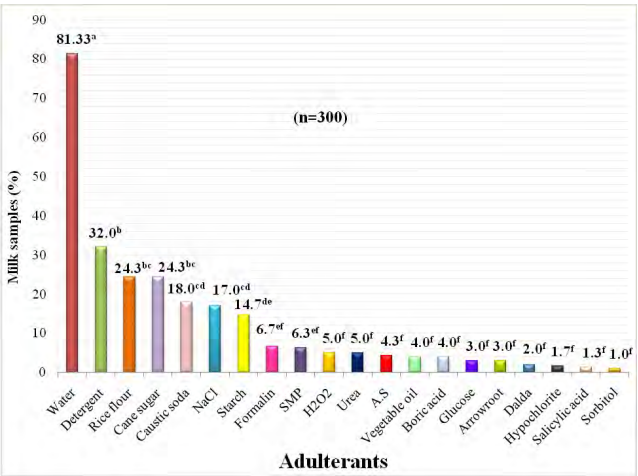

Figure 2: Percent of various adulterants over 300 milk samples at Sindh province.

Legends: AS = Ammonium Sulfate, H_2O_2 = Hydrogen Peroxide, NaCl = Sodium Chloride and SMP = Skimmed Milk Powder

LSD (0.05) = 8.4718

SE± = 4.1848

Formalin, hydrogen peroxide and urea were detected from considerable number of milk samples at central zone of Sindh province against present findings [31]. Latif et al. and Awan et al. [32], reported 46.66% and 8% formalin positive milk samples at Pakistan and 2% adulteration of formaldehyde was reported by Sanjeevani et al. [33], at India. It could be agreed that formalin used as a preservative of milk to increase the shelf life, is not only decreases the nutritive value of milk but it is also a carcinogenic agent [34-36] and Singuluri and Sukumaran [37] reported that 26% milk samples were found positive for hydrogen peroxide adulteration in India. Contrary, Barham [31] found 8.33% starch, 6.33% glucose and 1.66% hypochlorite in market milk samples at central zone compared to that of southern zone. Adam [38] reported 35.3% market milk samples positive for starch at Khartoum state of Sudan. Latif et al. and Nirwal et al. [39], were detected 86.66% positive milk samples for urea at Pakistan and 80% India. Friedle et al. [40], detected 0.20mg/kg hypochlorite/quaternary ammonium compounds in raw milk. In another study Melame et al. [41], reported that in India the addition of caustic soda/sodium hydroxide is frequently used as neutralizer by the milk dealers to prevent the spoilage of milk by neutralizing the pH and natural acidity of milk. The trend of caustic soda adulteration in milk, which already contains sodium work as slow poison for the patients of hypertension and heart ailments and it also alters the utilization of lysine by body, an essential amino acid in milk, which is mandatory for the better growth in infants [42]. In accordance Abbas et al. [43], and Wadekar et al. [44], reported approximately similar (16.67%) percentage of salt adulterated milk samples at Peshawar, Pakistan and India. However, the presence of vegetable oil and dalda in milk observed during present study was supported by Zia [45], who reported in Pakistan to maintain the fat ratio in milk most of the milk dealers admixed vegetable oil and/or dalda to it, in supporting Gale and Hu [46]. Sorbitol is a non-nutritive artificial sweetener which resembles with sugar and it is used throughout the world by milk venders to mask the poor quality of milk and milk products as an adulterant [47]. The results regarding the presence of skimmed milk powder in milk samples found at southern zone of Sindh province are not in line with the study conducted by Awais [23], who found 8% milk samples positive for skimmed milk powder at Hyderabad, Sindh, whilst samples 6% positive milk samples were recorded by Pitty [48] from Mizoram and Nagaland.

Freezing point and extent of extraneous water in market milk handled by different milk selling mediators at southern zone of Sindh, Pakistan

Market milk handled by different milk selling mediators at Karachi, Thatta and Badin cities of southern zone of Sindh province was evaluated for freezing point and extent of water adulteration and results are presented in table 1. In the current study among all three urban cities (Karachi, Thatta and Badin) of southern zone and in between different milk selling mediators the trend of freezing point of milk sampled from retailer (-0.421, -0.316 and -0.289°C), middleman (-0.437, -0.324 and -0.316°C), milk collector (-0.392, -0.356 and -0.345°C), processor (-0.490, -0.423 and -0.392°C) and producer (-0.532, -0.471 and -0.499°C) was significantly ($P<0.05$) looming towards water.

Analysis of Variance (ANOVA) further revealed that among all the urban cites the freezing point of milk sampled from retail, middleman and milk collector level at Badin and Thatta was noticed markedly

(P<0.05) high towards water compared to milk sampled from Karachi city of southern zone of Sindh, Pakistan. Similar trend of results was reported by Barham [49] and Barham et al. [50], for the freezing point of milk samples at retailer, milk collector and milk vender level (-0.313, 0.135, 0.137°C) and (-0.292°C, -0.316°C and -0.345°C) compared to that of processor and dairy farm (-0.476 and -0.392°C; -0.501 and -0.499°C) at the Nosharoferoz and coastal cities of Sindh. In favour of present results, other authors reported that freezing point of milk samples collected from dairy shops, middlemen and milk collectors was noted high due to the addition of extraneous water compared to processors and milk producers at Badin district of Sindh, Pakistan. In addition extraneous water in milk will have adverse effect on freezing point and nutritional quality [26,51].

Urban cities	Freezing point of milk samples (°C)				
	Producer	Milk collector	Middleman	Processor	Retailer
Karachi	-0.532^{g}	-0.392^{cd}	-0.437^{de}	-0.490^{fg}	-0.421^{d}
Thatta	-0.471^{ef}	-0.356^{bc}	-0.324^{ab}	-0.423^{d}	-0.316^{ab}
Badin	-0.499^{fg}	-0.345^{bc}	-0.316^{ab}	-0.392^{cd}	-0.289^{a}
LSD (0.05) = 0.0474 SE± = 0.0241					

Table 1: Freezing point of milk samples collected from different milk selling mediators at Karachi, Thatta and Badin cities of Southern zone of Sindh, Pakistan.

*Means with different letters in same row and column varied significantly from one another.

Extent of extraneous water in market milk handled by different milk selling mediators at southern zone of Sindh, Pakistan

Results mentioned in table 2 reveal that within Badin and Thatta cities of southern zone the average percent of extraneous water in milk handled by retailer (46.38 and 41.41%) and middleman (41.44 and 40.96%) was found comparatively (P<005) high followed by milk collector (35.91 and 34.02), processor (27.47 and 21.57%) and producer (12.88 and 7.62%) compared to that of milk sold in Karachi city at retailer level (22.13%) milk collector (27.29%), middleman (19.14%), processor (9.15%) and producer (1.53%), respectively. Moreover, the effect of all milk selling mediators, particularly retailer, middleman and milk collector in Thatta and Badin cities of southern zone of Sindh was dominant (P<0.05) on water adulteration in milk v/s processor and producer at Karachi. The findings of present research are supported by different researchers around the world. Barham et al. [50], observed highest extent of extraneous water in milk samples collected from dairy/retailer shops (46.40±3.47%), middlemen/vender (41.45±2.90%) and milk collectors (35.3±2.80%) compared to that of processor (27.50±4.52%) and milk producer (7.62±2.08%) at coastal areas of Sindh, Pakistan. Similar findings have been reported by Nida et al. [26], they reported that the extent of extraneous water was found to be higher in market milk samples as compared to dairy farms and by milk producers. Present findings are in agreement with that of Wadekar and Menkudale [52], who reported the vendors and dairy shop keeper are engaged in unethical activity of milk adulteration to increase their profit.

Urban cities	Extent of extraneous water (%)				
	Producer	Milk collector	Middleman	Processor	Retailer
Karachi	1.53^{g}	27.29^{cd}	19.14^{de}	9.15^{fg}	22.13^{d}
Thatta	7.62^{fg}	34.02^{bc}	40.03^{ab}	21.53^{de}	41.41^{ab}
Badin	12.88^{ef}	35.91^{bc}	41.44^{ab}	27.47^{cd}	46.38^{a}
LSD (0.05) = 8.7721 SE± = 4.4567					

Table 2: Extent of extraneous water in milk samples collected from different milk selling mediators at Karachi, Thatta and Badin cities of Southern zone of Sindh, Pakistan.

*Means with different letters in same row and column varied significantly from one another.

Conclusion

Raw milk marketing from production up to consumption level at southern zone of Sindh province of Pakistan observed to be based on traditional systems, where informal channels were involved in morally wrong practices of adulteration and among these, milk retailer found to be involved more followed by middleman, milk collector, processor and producer. Among all three urban cites of southern zone particularly at Thatta and Badin, the trend of freezing point of milk samples collected from retailer, middleman, milk collector, processor and producer was intimidating towards water and the extent of extraneous water adulteration in milk noted more contrast to that of Karachi city of southern zone.

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