INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 14, No. 2, p. 149-155, 2019
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Milk adulteration: An old traditional threat to public health in Quetta, Pakistan

Hafiz Muhammad Arif*[1], Nadeem Rashid[1], Majid Rafeeq[1], Babar Hilal[1], Shahzad Ahmad[2], Abdul Nasir[2], Muhammad Din[2]

[1]*Center for Advanced Studies in Vaccinology & Biotechnology (CASVAB), University of Balochistan, Quetta, Pakistan*

[2]*Livestock & Dairy Development Department, Quetta, Pakistan*

Article published on February 28, 2019

Key words: Milk adulteration, Quetta, Water, Balochistan.

Abstract

Balochistan is the largest province of Pakistan that makes 44% of the total geographical area of the country. Most of the area is rangelands with only 5% arable area. Animal agriculture is centuries old occupation of the people of Balochistan. Livestock are one of the major important sectors of the province having about 20% of the national stock. Quetta being capital of the province with more than 2million population. Generally the milk is supplied from neighboring areas like, Jacobabad, Sibi and even Multan in summer season. Dairy farms in Quetta are in small proportion that does not meet the demand of the city. Most the milk man adulterate the milk with water and even skim milk powder and sale it in retail outlets with substandard fat percentage. However, other common adulterants include, urea, oil, sugar, detergent, salts and chloroform etc. At government level no food safety authority exists in order to keep check on food item on regular basis. It is recommended that food safety authority may be constituted and regular survey may be conducted to overlook the milk adulteration. Furthermore, Milk testing facility may be provided at Provincial Diagnostic laboratory under Livestock Department in the area. This review intends to contribute towards consumer's knowledge and awareness with reference to possible adulteration and its detection techniques.

***Corresponding Author:** Dr Hafiz Muhammad Arif ✉ drhafizarif@gmail.com

Introduction

Agriculture sector in Pakistan plays key role in the economy of the country. It contributes 19% to the GDP and absorbs 19% labor force. While Livestock being sub sector shares 59% in agriculture (ESC, 2017). Balochistan being the largest province of the country where major occupation of the people is the livestock rearing as open farming system in free rangelands. The province has only 5% arable area only. The province is the cradle for many precious breeds of different animals. About 44% of total Sheep population of the country is rared here followed by goats, cattle and camels. Most of the population is rural based with tribal system of social life. Milk is the natural highly valuable and good source of highly source protein, vitamins and minerals. Natural pure milk has many advantages and is used for the treatment of different ailments in addition to basic primary diet of infants (Afzal *et al*., 2011). But if adulterated, it poses serious effects on the health of individuals. Adulteration is an international act that not only reduces the quality of milk but also keep the life on threat.

Generally, different non-natural products are added for different purposes such as increasing viscosity, preservation, high fat content and flavor etc. Several peer reviewed papers have documented the adulteration of milk more generally with water throughout the globe. Chemical adulterants are used for different purposes such as, starch, chlorine, hydrated lime, sodium carbonate, formalin and ammonium sulfate. To meet the shortfall of milk, synthetic milk is prepared by mixing urea, caustic soda, refined oil and common detergents that have many serious injurious effects over body health. Widespread use of these chemical preservatives especially in warm weather is a great concern in food industry. With the advancement of technology, newer techniques have been invented to detect different kinds of milk adulterants, but in the same pace the complex methods of milk adulteration and varieties of milk adulterants have been evolved. A large number of research papers have been published on milk adulteration and detection (Karoui & De Baerdemaeker, 2007).

This paper attempts to review two main milk adulterants commonly practiced in Quetta region, viz, Water and Powder milk. Although different detection techniques for individual adulterant and comprehensive studies have been carried out on the detection technology by electrical means. The biological components of the biosensor are enzymes, whole cells, tissues, receptors and antibodies. Many biosensors are integrated with the electrical sensors to detect milk adulteration. Often lactose concentration is used as a basic marker for the evaluation of milk quality and detection of abnormalities. It has been found that milk from cows suffering mastitis has low lactose levels (Conzuelo *et al*., 2010).

There has been extensive research in evaluating electronic noses for monitoring the quality of milk. E-nose can monitor the aging of milk and can detect milk volatile compounds (Capone *et al*., 2001). The two main components of an electronic nose (E-nose) are the sensing system and the automated pattern recognition system (Yu *et al*., 2007). The common pattern recognition systems are either principal component analysis (PCA), linear discriminant analysis (LDA) or artificial neural network (ANN). Potentiometric electronic tongues using lipid/ polymer membranes has the ability to classify vast kinds of chemical substances into several groups, which can be found in the taste reception in biological systems (Toko, 1998). The potentiometric electronic tongue reported by them includes an automatic sampling system, a sensor array with a reference electrode, a signal processing unit and a personal computer with the required software (Astree 3.0.1.). The data obtained from the electronic tongue is processed by principal components analysis (PCA) to get the variance in the experimental data (Hruskar *et al*., 2009).

Water adultration in Milk

Water addition not only increases the volume but causes change in density also. Estimation of freezing point (FP) of milk is the traditional standard test for water addition to milk samples. However, certain other commercial instruments are available for such determination and can evaluate more samples.

Lactometer is traditionally used for water estimation in milk samples in field conditions. However, now a days with the advent of newly developed technology Lactoscan, can estimate more parameters with high accuracy. Freezing Point is achieved, if the temperature of frozen milk does not change by 0.5milli degree Celsius over 20 seconds. Although it is simple test but is not a routine test. Addition of sugars and salts as preservatives decreases the FP of watered milk. Similarly, acidity development also cause problems while detecting the freezing Point. Infrared spectroscopy and chemometrics is another powerful tool for milk analysis. The combination of advanced instrumentation used in IR spectroscopy and chemometrics provides a powerful tool for quality and authenticity analysis of milk (Rodriguez-Saona *et al*., 2011). It has been used in combination with 2D correlation for milk adulterants analysis (He *et al*., 2010).

Detection of Synthetic Milk

This is yet another common practice in most of the countries. When milk sellers mix Synthetic powder milk to raw milk in order to increase the volume. More commonly it is admixed for curd preparation and preparation of more value-added products with more profits (Anita, 2013). Synthetic milk is reported to be used for the 5–10% ratio (PARADKAR *et al*., 2000). Addition of cheap power milk to raw unpasteurized milk is also a very common practice especially in low income countries. Certain assays such as, RNAase activity for determination in milk (Ju *et al*., 1991) are very useful for the estimation of milk powder in raw milk samples.

Capillary electrophoretic is another discriminatory method for the determination of adulteration of fresh milk with milk powders (Recio *et al*., 1997).

Emerging Methods

Conventional regular chemical methods have limited advantages in screening the adulterants in milk samples. However, newly introduced advanced techniques such as MIR, PCR, and NIR have been applied for the analysis of milk and dairy products (Table.1). Hand-held infrared (IR) spectrometers in conjunction with multivariate analysis have also been demonstrated by (Santos *et al*., 2013) for monitoring of milk adulteration by tap water, synthetic urine, urea, synthetic milk and hydrogen peroxide and whey.

Table 1. Different methods used for estimation of milk adulteration.

Sr No	Adulterants	Detection Methods	References
1	Chlorine	Sequential injection analysis	(Lima *et al*., 2004)
		Flow injection analysis	(Ferreira *et al*., 1994)
		Potentiometric detection	(Lima *et al*., 2000)
		Conductometric sequential injection analysis	(Silva *et al*., 1999)
2	Antibiotics	Electrical conductivity	(Janzekovic *et al*., 2009)
		BRT Test	(Molina *et al*., 2003)
		Spot Test	(Ryan *et al*., 1986)
		SNAP test and LACTEK test	(Escobar, 1999)
		Chromatography (HPLC)	(Perez *et al*., 2002)
		Liquid chromatography mass spectrometry	(Ghidini *et al*., 2003)
		Somatic cell count (SCC)	(Ruegg, 2005)
3	Non Milk Proteins	Fluorescence spectroscopy	(Ntakatsane *et al*., 2013)
		Analysis of triacylglycerols using gas liquid	(Timms, 1980)
		Chromatography NIR spectroscopy	(Sato *et al*., 1990)
		Electrical conductivity and capacitive reactance	(Lawton *et al*., 1993)
		Reversed Phase HPLC method in combination with fluorescence detector	(Luykx *et al*., 2007)
		Sulfate capillary electrophoresis and chromarography	(López-Tapia *et al*., 1999)
		E-nose	(Capone *et al*., 2000)
4	Low valued Milk	Optical biosensor (BIACORE 3000) tool	(Haasnoot *et al*., 2004)
		Duplex polymerase chain reaction	(Mafra *et al*., 2007)
		Gas chromatography	(Farag *et al*., 1984)
		ELISA and PCR techniques	(Lopez-Calleja *et al*., 2007)
		Reverse-phase high performance liquid chromatography and	(Veloso *et al*., 2002)
		TaqMan real time PCR	(Zhang *et al*., 2007)
		HPLC method	(Enne *et al*., 2005)
		Sandwich IgG ELISA	(Hurley *et al*., 2006)
5	Milk Powder	FAST (Fluorescence of advanced maillard products and soluble tryptophan)	(Guan *et al*., 2005)

Sr No	Adulterants	Detection Methods	References
6	Color	Capillary electrophoresis	(Huang *et al.*, 2002)
7	Preservative	Conductivity	(Grillo *et al.*, 2002)
		Impedance	(Biswas *et al.*, 2006)
8	Neutralizers	Conductivity or pH measurement	(Sadat *et al.*, 2006)
9	Urea	Potentiometric biosensor	(Trivedi *et al.*, 2009)
		pH measurement	(Luzzana & Giardino, 1999)
		Calorimetric method	(Bhavadasan, 2014)
		Biosensors	(Renny *et al.*, 2005)
10	Whey/ Liquid	Reverse phase HPLC method	(Olieman & Van Riel, 1989)
		Capillary Electrophoresis	(Recio *et al.*, 2000, Bremer *et al.*, 2008)
		ELISA	Recio *et al.*, 2000)
		Fourth derivative spectroscopy	(Miralles *et al.*, 2000)
		Blot immunoassay method	(Chávez *et al.*, 2008)
11	Water	Frequency admittance measurements	(Mabrook *et al.*, 2002)
		Electrical conductivity	(Mabrook *et al.*, 2003)
		Freezing point osmometry and cryoscopic method	(Mabrook *et al.*, 2002)

Conclusion

The ultimate aim of adulteration of milk is the gain of financial benefits. It is more frequently practiced in undeveloped countries where no or less effective food authority or regulatory body exists and even work in traditional way. Hypertension, renal, skin, eye diseases, heart problem and cancer are some of the common disease caused by consumption of adulterated milk. This study intends to alert the regional government to establish efficient regulatory and food safety authorities to ensure the supply of unadulterated milk to the communities. An early establishment of milk testing laboratory in the province is utmost necessary for smooth screening of milk samples.

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