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Detection of adulteration of raw cow's milk in Assiut City, Egypt

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Abstract

A total of 100 raw cow's milk samples were randomly collected from dairy shops and street vendors (50 samples each) in Assiut city, Egypt. Samples were examined for detection of adulteration and heat treatment. Automatic milk analyzer was used for determination of density, added water %, freezing point, fat%, S.N.F% for the detection of adulteration by addition of water and partial skimming. Also, milk samples were examined by general and specific tests for detection of inhibitory substances, as well as detection of some commercial additives and heat treatment. The results revealed adulteration of milk samples in different percentages. Street vendors' milk samples were subjected to more adulteration than that of dairy shops. It could be concluded that milk marketed in Assiut city is produced and handled under inadequate control measures allowing greedy retailers and producers to adulterate milk to increase their gain.

Keywords: Adulteration, milk analyzer, inhibitory substances, heat treatment.

Introduction

Milk is considered as the most nearly perfect food. It is of big value in promoting growth and development of children. Also, milk is important in our diets throughout our adult life, as well as for infant and children.

Adulteration is an act changing the quality of food either by adding inferior substances or by the removal of some valuable ingredients ***(FDA, 1995).*** Despite food legislation, adulteration remains uncontrolled.
Adulteration of milk is of great importance for financial and potentially health reasons. Consumers are deceived into consuming a product whose chemical composition is altered and paying for a product of inferior quality, and finally may be at risk for allergies especially during the first years of life **(*Lara-Villoslada et al., 2005*).**

Adulteration of milk has many forms; addition of water is probably the oldest form. Water is added to increase the volume of milk which in turn decreases the milk solids not fat especially proteins which are important for normal growth. Moreover, if the added water is contaminated, it poses a health risk especially to infants and children. Also, skimming is a well known form of adulteration that inhibits the utilization of fat and fat soluble vitamins which are important for the human body.

Some chemicals such as hydrogen peroxide, formalin, salicylic acid, boric acid, borax, carbonates, bicarbonates, and even antibiotics are added to milk to extend its shelf life in spite of its bad effect on health.
Thickening agents such as starch and skim milk powder are added to increase the solids content of milk thus make up the density of milk to prevent the detection of added water. Also, heat treatment of milk sold as raw milk is considered a type of adulteration. The main aim of this study was to detect adulteration in raw cow's milk marketed in Assiut City and mention the recommended control measures to prevent it.

Materials and Methods

I- Collection of samples:

A total of 100 raw cow's milk samples marketed in Assiut city were randomly collected from dairy shops and street vendors (50 samples each). Samples were collected in clean, dry and sterile containers, and transferred to the laboratory with a minimum of delay.

II- Analysis of samples:

A- Physical and chemical examination:

Determination of density, added water percentage, freezing point, fat percentage and milk solids not fat percentage was performed in the Department Food Hygiene, Faculty of Veterinary Medicine, Assiut University, using automatic milk analyzer (Milk Analyzer Lactoscan MCC, Milkotronic LTD) ***(Draaiyer et al., 2009)***.

B- Detection of inhibitory substances

1- Detection of inhibitory substances according to ***(A.P.H.A., 1992)***
2- Detection of preservatives: Hydrogen peroxide, Formalin, Salicylic acid, Boric acid & borax were performed according to ***(Ling, 1963)***. While, detection of carbonate and bi-carbonate was performed according to ***(Parikh, 1945).***

C- Detection of commercial additives: Detection of Starch and skim milk powder according to ***(Parikh, 1945).***

D- Detection of heat treatment by Storch's test according to ***(Lampert, 1975).***

Results

Table 1. Added water in the examined cow's milk samples

Samples	Positive samples		Added water %		
	No./50	%	Minimum	Maximum	Average
Dairy shops	21	42	2.5	21.73	16.02
Street vendors	34	68	5.96	23.84	16.96

Table 2. Frequency distribution of the examined cow's milk samples based on their added water %

Added water	Dairy shops		Street vendors	
	No./50	%	No./50	%
- 10	5	10	9	18
- 20	7	14	8	16
- 30	9	18	17	34

Table 3. Freezing point of the examined cow's milk samples

Samples	Examined samples	Freezing point		
		Minimum	Maximum	Average
Dairy shops	50	- 0.617	- 0.407	- 0.489
Street vendors	50	- 0.571	- 0.396	- 0.462

Table 4. Frequency distribution of the examined cow's milk samples based on their freezing point

Freezing point	Dairy shops		Street vendors	
	No./50	%	No./50	%
- 0.370 -	9	18	17	34
- 0.410 -	7	14	8	16
- 0.450 -	2	4	8	16
- 0.490 -	3	6	1	2
- 0.530 -	27	54	15	30
- 0.570 -	2	4	1	2

Table 5. Density of the examined cow's milk samples

Samples	Examined samples	Density		
		Minimum	Maximum	Average
Dairy shops	50	1.023	1.035	1.029
Street vendors	50	1.021	1.034	1.027

Table 6. Frequency distribution of the examined cow's milk samples based on their density

Density	Dairy shops		Street vendors	
	No./50	%	No./50	%
1.020 -	4	8	12	24
1.024 -	13	26	17	34
1.028 -	17	34	12	24
1.032 -	14	28	9	18
1.035 -	2	4	-	-

Table 7. Fat % of the examined cow's milk samples

Samples	Examined samples	Fat%		
		Minimum	Maximum	Average
Dairy shops	50	2.01	4.90	3.23
Street vendors	50	1.12	3.89	2.86

Table 8. Frequency distribution of the examined cow's milk samples based on their fat %

Fat%	Dairy shops		Street vendors	
	No./50	%	No./50	%
1.0 -	-	-	3	6
2.0 -	17	34	20	40
3.0 -	22	44	27	54
4.0 -	11	22	-	-

Table 9. Milk solids not fat % of the examined cow's milk samples

Samples	Examined samples	S.N.F%		
		Minimum	Maximum	Average
Dairy shops	50	6.54	9.71	8.2
Street vendors	50	6.44	9.22	7.69

Table 10. Frequency distribution of the examined cow's milk samples based on their S.N.F %

S.N.F %	Dairy shops		Street vendors	
	No./50	%	No./50	%
6.25 -	9	18	17	34
7.25 -	12	24	17	34
8.25 -	23	46	16	32
9.25 -	6	12	-	-

Table 11. Heat treatment, inhibitory substances and additives in the examined cow's milk samples

Tests	Dairy shops		Street vendors	
	No./50	%	No./50	%
Storch test	6	12	13	26
Diffusion test	19	38	21	42
Hydrogen peroxide	1	2	-	-
Formalin	-	-	-	-
Salicylic acid	-	-	-	-
Boric acid & borax	2	4	1	2
Carbonate & bicarbonate	3	6	2	4
Starch	-	-	-	-
Skim milk powder	-	-	-	-

Table 12. Milk samples with legal and illegal content values on comparison with the Egyptian standards

Source of milk	Added water%		Freezing point		Density		Fat%		S.N.F.%	
	L.	I.L.	L.	I.L.	L.	I.L.	L.	I.L.	L.	I.L.
Dairy shops	58	42	54	46	62	38	66	34	58	42
Street vendors	32	68	30	70	42	58	54	46	32	68

L.: Legal I.L.: Illegal

Egyptian standards: Freezing point - 0.530 : - 0.560 Density 1.028 : 1.034 Fat% 3% S.N.F. 8.25%

Discussion

Adulteration of milk is one of the most serious issues in Egypt, which not only causes major economic losses, but also a major health risk for the consumers.

Unfortunately, due to non-regulated marketing systems, the quality of milk is hardly maintained at the consumer level ***(Javaid et al., 2009)***. Some illegal measures are adopted to increase the shelf life of milk in order to reduce the financial losses due to spoilage of milk during its transportation and sale.

The data in Tables 1&2 pointed out that 42% of the examined milk samples collected from the dairy shops and 68% of the street vendors' samples were adulterated with water, ranging from 2.5: 21.73 and 5.96: 23.84 for dairy shops and street vendors' samples respectively. The highest frequency distribution was in the range 20-30% added water.
It is obvious that milk samples of street vendors were more subjected to adulteration by addition of water than that of dairy shops. We are concerned not only to the percentages of the added water, but also to the quality of that water. The adulteration of milk by addition of water not only reduces the nutritional value of milk, but also constitutes as a source of various microorganisms, harmful chemicals and poisonous substances and become a health risk to the consumer.

The results in Table 12 showed that 58% of dairy shops samples and 32% of street vendors' samples were free from adulteration with added water as supposed by the Egyptian regulations.

Results summarized in Tables 3&4 showed that the freezing point of dairy shops milk samples ranged from – 0.617 to – 0.407 with an average of – 0.489, while for the street vendors samples, it ranged from – 0.571 to – 0.396 with an average – 0.462. The highest frequency distributions (54% and 34%) were in the range – 0.530 to – 0.560 and – 0.370 to – 0.400 for dairy shops and street vendors' samples respectively. Comparing the results with the Egyptian regulations (-0.53 to – 0.56) ***(Egyptian Standards, 2005)***, 54% of dairy shops samples and 30% of street vendors' samples were coincide with it. The rest of the samples were above the legal limit owing to their adulteration with water (Table 12).

The data presented in Tables 5 & 6 showed that the density of the dairy shops samples ranged from 1.023 to 1.035 and the street vendors' samples ranged from 1.021 to 1.034 with an average of 1.029 and 1.027 respectively. The highest frequency distribution was 34% for each of the dairy shops and street vendors' samples. It was in the range 1.028 – 1.031 for the dairy shops samples and 1.024 – 1.027 for the street

vendors' samples. As recorded in Table 12, 62% & 42% of dairy shops and street vendors' samples were within the legal limit (1.028 – 1.034) as regulated by ***(Egyptian Standards, 2005).*** The rest of the samples were lower than the normal value which is due to adulteration by addition of water, whereas 4% of dairy shops samples were above the normal value which could be due to adulteration by partial skimming.

Tables 7 & 8 showed that the fat% in milk of dairy shops had a minimum of 2.01 and a maximum of 4.90 with an average of 3.23, whereas in milk of street vendors' the minimum was 1.12, the maximum was 3.89 and the average was 2.86. The highest frequency distributions were 44% & 54% in the range 3.0 – 3.9. Comparing these results with the legal value of fat% (not less than 3%) ***(Egyptian Standards, 2005),*** 66% & 54% of dairy shops and street vendors' samples were coinciding with the Egyptian regulations (Table 12). The results of fat% of street vendors' milk samples were quite unexpected as more than half the samples were within the legal value. Higher incidence of skimming was recorded in previous studies ***(Abdel-Sabour, 2007)***.

Results given in Tables 9 &10 revealed that the S.N.F. of milk of dairy shops had a minimum of 6.54, a maximum of 9.71 and an average of 8.2. The highest frequency distribution (46%) ranged from 8.25 to 9.24. As for milk of street vendors', it ranged from 6.44 to 9.22 with an average 7.69. The highest frequency distribution (68%) ranged from 6.25 to 8.24. Results in Table 12, showed that 58% & 32% of dairy shops & street vendors' milk samples were within the normal range of S.N.F. (not less than 8.25%) ***(Egyptian Standards, 2005).*** It is noticed that the percentages of milk samples with added water and samples with solids not fat below the normal value are the same. It is noteworthy that the decrease of S.N.F. is attributed to the adulteration of milk by addition of water only ***(Harding, 1995).***

It is clearly evident from Table 11 that 12% and 26% of dairy shops and street vendors' samples were heat treated. These results were nearly similar to that reported by ***Abdel-Sabour (2007)*** and ***El- Shameya (2014)***, while ***Deeb (2000)*** and ***El-Bessary (2006)*** couldn't detect heat treatment. Heat treatment act as a common type of adulteration as it covers the unsanitary conditions under which milk is produced ***(Mansour et al., 2007)***. Also, off flavors and denaturation of protein may occur as a result of milk heating.

The data represented in Table 11 showed that 38% and 42% of dairy shops and street vendors' samples were positive for inhibitory substances when tested by the diffusion test. Lower results were obtained by ***El-Shameya (2014),*** while higher results were recorded by ***Abdel-Sabour (2007).***

Presence of inhibitory substances in milk is regarded as a health hazard as they may have carcinogenic effects. Addition of any kind of preservative to milk is considered an illegal action as they have adverse effect on health. Hydrogen peroxide disturbs the antioxidants in the body which disturbs the natural immunity therefore increasing aging. Carbonates cause gastrointestinal problems including diarrhea, gastric and colon ulcers ***(Ayub et al., 2007).***

Regarding the different types of preservatives present in milk samples, it is obvious from Table 11 that hydrogen peroxide, boric acid, borax, carbonate & bicarbonate were present at different percentages in the examined milk samples, while formalin and salicylic acid were not present.

The positive samples of inhibitory substances detected by the diffusion test and not containing the examined preservatives may contain antibiotics or any other inhibitory substance that passed to milk via treatment of animals or added by milk sellers to prolong the keeping quality. Previous studies conducted in Assiut detected preservatives but in different percentages ***(Wahba and Korashy, 2006 & Abdel-Sabour, 2007).***

Results in Table 11 showed that all samples were free from starch and skimmed milk powder. Similar results were reported by ***(Abdel-Sabour, 2007; El- Shameya (2014) and Makadiya and Pandey, 2015)*** while ***Arora et al. (2004)*** could detect starch in milk samples.

As a conclusion of this work, market raw milk in Assiut city is produced and handled under neglected sanitary measures. Also, milk of street vendors is subjected to adulteration more than dairy shops' milk. Therefore, it is recommended for the authorities to confirm the quality of raw milk sold in markets.

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