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A comparative study on the physicochemical properties, composition and extent of adulterants present in raw milk

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A B S T R A C T

The present study was done to detect the various adulterants with a number of toxic substances in natural milk. In this study we explained the hygienic status, physical properties like color, odour, consistency, P^H sedimente.tc, physicochemical properties like specific gravity and acidity and also detected for presence of various adulterants like starch, cane sugar, pulverized soap, urea, ammonium sulphate, formaldehyde, coloring matter, nitrates in raw milk collected from different areas of local market. A total of 10 samples were collected from different areas localities in Ananthapuramu and determined physical properties and also extent of adulteration. From this study we found various observations like all milk samples were found have similar physical and physicochemical properties with slight variations. No samples were adultered with starch, cane sugar, pulverized soap, ammonium sulphate, formaldehyde, coloring matter, nitrates. All samples were found to be adulterated with urea and skimmed milk.

Keywords: skimmed milk, solids not fats, ammonium sulphate, formaldehyde, coloring matter

A R T I C L E   I N F O

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1. Introduction

Milk is an important source of nutrient required for growth in infants and children and for maintenance of health in adults. Milk is a perfect food, readily digested and absorbed. It is a sole natural food for infants and children. It is chiefly a valuable source of good quality protein, fat, carbohydrates, vitamins and minerals. Protein in diet supply the amino acids required for growth of infants and children. It is also required for maintenance of tissues in adults.[1]

Milk contains more than 100 substances that are either in solution, suspension or emulsion in water, the important being casein - the major protein of milk, lactose - milk sugar, whey and mineral salts[2]. An adulterant is a chemical substance which should not be contained within other substances (e.g. Food, beverages, and fuels) for legal or other reasons. The addition of adulterants is called adulteration. The word is appropriate only when the additions are unwanted by the recipient. Otherwise the expression would be food additive. Adulterants when used in illicit drugs are called cutting agents, while deliberate addition of toxic adulterants to food or other products for human consumption is known as poisoning.[3]

In India, milk is the largest and the most important commodity within the livestock sector. The milk of different species contains the same constituents in general. On average, milk is made up of 87.4% water and 12.6% milk solids (3.7% fat, 8.9% milk solids-not-fat). The milk solids-not-fat contains protein (3.4%), lactose (4.8%), and minerals (0.7%).

Milk fat often called "butter fat" is commercially, the most valuable constituent of milk. It is also of great importance from the standpoint of the food value of the milk. The agreeable flavor of rich milk and to a large extent of other dairy products is largely due to the milk fat. Proteins are among the most complex of organic substances. They contain carbon, hydrogen, oxygen, nitrogen, sulfur and sometimes phosphorus. The protein of milk is not a single compound but includes two major proteins and small quantities of others. Between them casein constitute about 80 % of the total and lacto albumin 18%. A third protein recognized as present in milk is lacto globulin. It is present in very small amounts, probably about 0.05 to 0.07 %. Ash constituents of milk are extremely important in their relation to the heat stability of the milk.[4]

The adulteration of milk is banned due to the ill effects. Carbonate in milk produce gastrointestinal problems including gastric ulcer, diarrhea and colon ulcer and electrolytes disturbance. The hydrogen peroxide disturbs the antioxidants in the body disturbing the natural immunity hence increasing aging. Chloride in the milk disturbs the acid base balance in the body and also blood ph. Ammonia in milk develops regression, loss of acquired speech and sensory disturbances[4]. The aim of this study is to analyze the fresh milk samples for composition and adulteration. So that to aware the people of that area about its nutrition and ill effects on their health.

2. Materials and method

Materials:

Study was conducted to determine the physical, physico-chemical, chemical composition of milk and observe the extent of adulteration and its influence on the chemical characteristics of market milk sold at Ananthapuramu. A ten different fresh milk samples were collected randomly from each area and analyzed for the physical properties, physico-chemical properties, chemical composition and extent of adulteration by various chemical tests. All chemicals used for the test is analytical grade. All chemicals for determining adulterants used were of analytical grade.

Methodology:

I. Collection of samples: A total of 9 random samples of raw buffalo's milk and one sample of raw cow milk were collected in clean, dry and sterile containers from different localities of Ananthapuramu.

II. Preparation of samples:

Each milk sample (250ml) was thoroughly mixed before being divided into 4 sub-samples. The first was used for physical examination; the second was used for chemical examination; the third was used for determination of composition and the fourth was used for detection of common commercial adulterants.

III. Analysis of samples:

Physical examination: Each milk samples was observed for color, odor, p^H, consistency and sediment.

Chemical examination:

Acidity and average specific gravity of milk was determined by using following procedures.

Titratable acidity of milk

Titratable acidity of the milk samples was determined according to the method of the association of official analytical chemists (AOAC). 9 ml of milk sample was pipetted into a beaker and 3 to 5 drops of 1% phenolphthalein indicator was added to it. The milk sample was then titrated with 0.1N NAOH solutions until a faint pink color persisted. The titratable acidity, expressed as % lactic acid, was finally calculated using the following formula.

Titratable acidity (%) = $\underline{N/10\ NAOH\ (ml) \times 0.009}$/ weight of milk sample x 100

Specific gravity:

Fresh milk sample was filled sufficiently into a glass cylinder (100ml capacity). Then, lactometer was hold by the tip and inserted into the milk. The lactometer was allowed to float freely until it reached equilibrium. Then the lactometer reading at the lower meniscus was recorded. At the same time, thermometer was inserted into the milk sample and the temperature of the milk was recorded. The following formula was used to calculate the specific gravity of the milk.

$$\text{Specific gravity} = (l/1000) + 1$$

Where, l = corrected lactometer reading at a given temperature, that is, or every degree above 15.56°c, 0.2 was added to the lactometer reading but for every degree

below 15.56°c, 0.2 was subtracted from the lactometer reading .

Determination of chemical composition:
Parameter like percent protein, fat, total solids, SNF of milk was determined by using standard procedures. Protein% was measured by titration method. Fat% by Gerber's method. SNF and total solids by Fleischmann's formula. Percentage of water was measured by presence and extent of extraneous water in milk samples was detected by depression of freezing point (through Cryoscope) and calculated by using following formula.
%Extraneous water=Freezing point base-observed freezing point/freezing point base×100

Detection of extent of adulteration:
Various milk adulterants like starch, cane sugar, pulverized soap, urea, ammonium sulphate, water, nitrates, coloring matter, skimmed milk, formalin was detected by using following standard procedures

Test for starch: 3ml well mixed sample is taken in a test tube. It is boiled to boil over flame, cooled to room temperature. A drop of 1%iodine solution is added and mixed. Appearance of blue color indicates the presence of starch which dis appears on boiling and reappears on cooling.

Test for cane sugar:
To about 10ml milk in a test tube, add 1ml conc.Hcl and 0.1g resorcinol and mix. Place the test tube in boiling water for 5min.in the presence of cane sugar {sucrose}, red color is produced.

Test for pulverized soap:
To 10ml milk in a test tube, 10ml hot water is added followed by 2-3 drops of phenolphthalein indicator. Development of red or pink color denotes the presence of soap in milk.

Test for urea:
Take 5ml milk and add equal volume of 24% Trichloro acetic acid to precipitate fat and proteins of milk. Filter and collect filtrate. Take 1ml filtrate and add 0.5ml sodium hypo chlorite (2%), 0.5ml phenol solution (5%), 0.5ml sodium hydroxide (5%) and mix. A characteristic blue or bluish green color develops in presence of added urea whereas pure milk remains colorless.

Test for ammonium sulphate:
Take 2ml milk in a test tube and add 0.5ml NAOH (2%), 0.5ml sodium hypochlorite (2%) and 0.5ml phenol (5%) heat in boiling water for 20sec.a bluish color forms immediately, which turns deep blue afterward. Pure milk shows salmon pink color which gradually changes to bluish after 2hours.3

Test for water:
Though the adulteration of milk with water can be checked by lactometer reading, other adulterations too affect the lactometer reading. Hence freezing point depression, recognized by AOAC, is usually adopted.

Percentage of water added = normal freezing point – observed freezing point x 100.

Normal freezing point of milk is taken as –0.55°c. A tolerance level of 3% is given which is equivalent to specifying a minimum freezing point depression for authentic milk of –0.55°c.

Test for nitrates: Take 10ml milk in a beaker. Add 10ml mercuric chloride solution (2.5% in 1%hcl) mix well and filter through what man no42 filter paper.

Test for coloring matter:
Add a few drops of hydrochloric acid to milk. Development of pink color indicates Azo dyes.

Test for formalin:
To about 10ml milk in a test tube, add 5ml conc. Sulphuric acid containing traces of ferric chloride is added slowly along the side of the test tube so that it forms a layer at the bottom, without mixing with the milk. The development of a violet or blue color ring at the junction of the two liquids indicates the presence of formaldehyde.

3. Results and Discussion

From the study of physical parameters like color, samples from S1to S6, S8, S9, and S10 were found to be in milk white and S7 was found to be in yellowish white. In the determination of odour, samples from S1 to S5 and S8 to S10 were found to be very mild whereas samples S6 and S7 were found to be normal. In P^H determination, samples S1 & S6 were found to have 5.3, S2 and S4 is 5.5, S3 and S8 is 5.4, S5 is 5.2, S7 and S9 is 5.1, and S10 the P^H was found to be 6.5. In determination of consistency all samples from S1 to S10 were found to be normal. In determination of sediment, samples from S1 to S5 and S8 to S10 were showed sediment whereas S6 and S7 do not show any sediment.

From the determination of chemical composition study of various milk samples we found that the % of fat in samples S1 and S2 is 3 %, in samples S3, S4, S6 and S7 was found to be 3.1%, in sample S5 is 3.2%, in S8 found to be 3.3%, in S9 it is found to be 3.8% and in S10 it was found to be 2 %. In the determination % of proteins study we found that in S1 it is 3.50%, S2 is 3.52%, S3 is 3.54 %, S4 is 3.70%, S5 is 3.78%, S6 is 3.74%, S7 is 3.64%, S8 is 3.68%, S9 is 3.72 and in S10 it was found to be 3.80%. In the determination % of water in the milk samples we found that in S1 it is 82.1%, S2 is, S3 is 84.5%, S4 is 84.8%, S5 is 81.3%, S6 is 82.6%, S7 is 84.8%, S8 and S9 is 83.2%, S10 is 81%. In the determination of SNF in milk samples we found that in S1, S2, S4, S6 is 1.1and S3,S5,S7,S8 is1.12, S9 and S10 is 1.13. In the determination of total solids in milk samples we found that in S1,S2,S7 and S9 is 4.1, S3, S4,S6 and in S10 it is 4.2, in S5 is 4.3, in S8 is 3.92.

In determination of extent of various adulterants like starch, cane sugar, pulverized soap, urea, ammonium water, sulphate, nitrates, coloring matter and formalin in all the milk samples we found that all the tests gave negative results for detection of adulterants like starch, cane sugar, pulverized soap, ammonium water, sulphate, nitrates, coloring matter, formalin and all samples gave positive results for the detection of urea.

Table 1: physical parameters

S.No	Sample name	Physical parameters				
		Color	Odour	P^H	Consistency	Sediment
1	S1	Milk white	Very mild	5.3	Normal	Yes
2	S2	Milk white	Verymild	5.5	Normal	Yes
3	S3	Milk white	Verymild	5.4	Normal	Yes
4	S4	Milk white	Verymild	5.5	Normal	Yes
5	S5	Milk white	Verymild	5.2	Normal	Yes
6	S6	Milk white	Normal	5.3	Normal	No
7	S7	Yellowish white	Normal	5.1	Normal	No
8	S8	Milk white	Very mild	5.4	Normal	Yes
9	S9	Milk white	Verymild	5.1	Normal	Yes
10	S10	Milk white	Verymild	6.5	Normal	Yes

Table 2: Physico- Chemical Parameters

S.No	Sample name	Specific gravity	Acidity
1	S1	1.016	0.07-0.08
2	S2	1.015	0.09-0.10
3	S3	1.005	0.08-0.09
4	S4	1.013	0.09-0.10
5	S5	1.085	0.06-0.07
6	S6	1.092	0.07-0.08
7	S7	0.986	0.06-0.08
8	S8	1.084	0.08-0.09
9	S9	0.995	0.06-0.08
10	S10	0.976	0.05-0.06

Table 3: Chemical Composition

S.No	Chemical Constituents	Sample name									
		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Fat (%)	3	3	3.1	3.1	3.2	3.1	3.1	3.3	3.8	2
2	Protein (%)	3.50	3.52	3.54	3.70	3.78	3.74	3.64	3.68	3.72	3.80
3	Water (%)	82.1	83.8	84.5	84.8	81.3	82.6	84.8	83.2	83.2	81
4	SNF	1.1	1.1	1.12	1.11	1.12	1.11	1.12	1.12	1.13	1.13
5	Total solids	4.1	4.1	4.2	4.2	4.3	4.2	4.1	3.92	4.1	4.2

Table 4: Extent of adulteration

S. No	Adulterant	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Starch	- ve	- ve	- ve	-ve	- ve	- ve	- ve	- ve	- ve	- ve
2	Cane sugar	- ve	-ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve
3	Pulverized soap	- ve	- ve	- ve	-ve	- ve	- ve	- ve	- ve	-ve	- ve
4	Urea	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve
5	Ammonium sulphate	-ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve
6	Water	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve
7	Nitrates	- ve	- ve	- ve	- ve	- ve	-ve	- ve	- ve	- ve	- ve
8	Coloring matter	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve
9	Formalin	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve

+ve Presence   -veabsence

4. Conclusion

On the basis of results obtained we conclude that the in determination of physical parameters like color almost all samples were in white color but S6 was found to be in yellowish white, odour of S1, S5, S8, S10 were very mild whereas remaining samples were found to be normal, P^H of samples from S1 to S9 were between 5.1 -5.5 and s10 was found to be 5, the consistency of all samples was found to be normal, S1 to S5 and S8 to S10 shown sediment and no sediment was observed in S6 and S7.the specific gravity of all sample were found to be between 0.976-1.092, the % acidity of S10 is 0.05% and the % of water content is more in S7 is 88% and in S10 it 81% ,in extent adulteration all samples were found to be adulterated with urea.

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