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Present Status of Adulteration in Milk in Jaipur

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Abstract: *Food adulteration is an intentional act of debasing the quality of food by unscrupulous traders and manufacturer by either addition of adulterants, substituting inferior substances or removing healthy ingredient. At the end, the ultimate victim is the innocent consumer. Milk is a basic source of food, providing abundant of nutrients to humans. Milk adulteration came into concern globally after the rise of Chinese milk scandal where contamination of melamine in milk was detected in 2008. Adulteration of milk is a global concern as the cases are worse in the developing and underdeveloped countries due to the unawareness, improper law enforcement and inadequate knowledge. Possible causes of milk adulteration can be profit making, demand & supply gap, unorganised dairy industry, lack of vigilance and to increase the life shell period of milk. The present work contains the information about food adulteration especially milk, common adulterants, causes of adulteration and their health hazards on humans, acts to prevent food adulteration in India. Various samples were collected from the pink city Jaipur and the qualitative lab tests were performed to detect the presence of adulterants in milk. The results are briefly discussed in this dissertation showing water, common salts and benzoic acid as the common adulterants found in the samples of Jaipur city.*

Key Words: *Adulteration, Baby milk scandal, Dairy products, Food safety, Preservatives.*

1. INTRODUCTION:

The easily available source of energy for human is milk. Milk is considered as the "ideal food" for humans. But this ideal food may affect human health positively as well as negatively. Adulteration of food influence its nutritional benefits i.e. its quality so the consumer should know about the food they depend upon for their survival.

A. ***Milk***

Milk is basically a white liquid secreted by the mammary gland of female mammals to feed their child after birth as a source of nutrition because the infant is not able to digest other type of food. In food use, from 1961 the term milk has been defined under Codex Alimentarius standards as: "The normal mammary secretions of milking animals obtained from one or more milking without either addition to it or extraction from it, intended for consumption as liquid milk or for further processing" [1].

B. ***Adulteration***

Now days Adulteration has become very common in the food industry. It reduces the quality of substance leading to harmful effects. Adulteration is an illegal act of mixing or adding matter or substance of an inferior or hazardous substance to the food leading to decrease in the quality and harmful effects. Adulteration can be done intentionally and non-intentionally. Food is generally adulterated intentionally to increase the amount of food and thus for traders' profit. Unintentional adulteration is due to the ignorance or lack of facilities to maintain the quality of food.

Milk adulteration came into limelight after melamine contamination in infant milk product in China. Milk is easily adulterated throughout the world and is not recognized by consumers due to lack of knowledge and absence of law enforcement[2].

In general, consumption of adultered milk regularly can lead to malfunctioning of organs, heart issues, cancer, poor sight, kidney problems and death.

C. ***Special cases of Milk***

The common adulterants in milk are:-Water, Melamine, Urea, Sugar, Salt, Starch, Chlorine, Sodium bicarbonate, Formalin, Ammonium sulphate, Hydrogen peroxides, Caustic soda, Refined acid, Common detergents, Coloring matter, Nitrates, Benzoic acid, Salicylic acid, Borax and Boric acid , Skimmed milk powder, Glucose, antibiotics, pesticides, whey, preservatives, low valued milk, non-milk protein and fats[3-9].Milk fraud has been reported widely in developing countries.

- **Swill milk scandal** happened in New York and became the major adulteration food scandal in 1850. It was found that nearly 8000 infants died in 1 year. Cows were fed with swill and later the milk was adulterated with water, eggs, hue, flour, plaster of paris to increase the volume and maintain whiteness and thickness[10].

- **Morinaga milk arsenic poisoning incident** -In 1955, Morinaga milk company in japan added monosodium phosphate additive containing 5-8% arsenic to the milk which resulted in strange sickness in infants like diarrhea, constipation, vomiting, swollen abdomen. This incident caused mental retardation in around 6000 people and 600 deaths[11].
- Belgian PCB/Dioxin incident in 1999(unintentional)
- **Iodine toxicity** from soy milk in New Zealand Many cases of thyroid dysfunction were reported in 2004 in adults and hypothyroidism in neonates. This incident occurred due to high levels of iodine in the product which was added purposely for enrichment. A similar case happened in 2009 in New Zealand[12].
- **Baby Milk scandal** -The 2008 Chinese milk scandal involved milk and infant formula begin adulterated with melamine. Melamine added to milk for higher protein content fraudly affecting over 300000 babies (i.e. protein deficiency), 51900 admitted and 6 infant death. Limit has been set by European states food and drugs administration (USFDA) i.e. max 2.5 mg/kg for melamine in imported foods and 1 mg/kg infants' formula. This was also adopted by codex Alimentarius commission with some rule in 2010[13,14,15].
- 2008- Italy dioxin in buffalo milk -buffalo milk was contaminated (unintentionally) with dioxin due to the presence of byproducts of industries which affected the soil and water.

D. Causes of Adulteration

Adulteration has become a health menace. The so-called modernization raise the evils of adulteration.

1) Population: India is the largest producers as well as consumer of milk. High demand for dairy products worsens the situation of adulteration in country.
2) Lack of public awareness is also major concern about the food safety acts.
3) Lack of knowledge in terms of the health risk caused with adulterants.
4) Traders cheat the consumers to gain economical profits.
5) Low availability of authentic ingredients at affordable prices.
6) Availability of many products in market, competition in market to bring new products with different brands and publicizes with known personalities attracts customers.
7) Consumer mentality of bargaining or their low buying habits.
8) Ease at availability of adulterants and easy methods for production.
9) Implication of law: Lack of surveys and facilities like money issues, underdeveloped laboratories, inadequate technology support, poor qualified lab technician, legal delays in punishments.
10) No fear of punishment in the traders, retailers, vendors, processors, etc.

TABLE1. USE OF ADULTERANT & ITS EFFECT ON HEALTH

ADULTERANTS	WHY USED??	EFFECT ON HEALTH
Water	Increase the quantity	Drops down the nutritive value
Sugar	Increase carbohydrate content & density of milk	Hormonal balance, Cu deficiency, ovarian cancer, causes anxiety hyperactivity
Starch	Increase solid content	Irritation of eyes, skin, cough, chest pain
Common salt	Add thickness & viscosity of diluted milk	Heartburn, asthma, hypertension, gastric cancer
Hydrogen peroxide	Reduces the cost of processing	Enhance ageing, gastritis & inflammation
Preservatives	Helps in preservation of milk for longer time.	Abdominal pain, diarrhea, vomiting, extreme case-death
Urea	Whiteness, balances SNF content	Acidity ,indigestion, ulcers , cancers, harms heart, liver &kidney
Detergent & soap	Emulsify ,increases cosmetic nature of product	Gastrointestinal problems

2. MATERIALS:

1)Chemicals required:

1) Concentrated Sulphuric acid
2) Concentrated Hydrochloric acid
3) Resorcinol

4) 1% Iodine solution
5) 0.1 N silver Nitrate solution
6) 10% Potassium Chromate solution
7) Potassium Iodide -starch reagent (20% KI solution + 1% starch solution)
8) 0.5% ferric Chloride
9) 2% Sodium hydroxide
10) 2% Sodium Hypochlorite
11) 5% Phenol solution
12) TCA solution
13) 5% Barium Chloride solution
14) Diphenylamine sulphate
15) 0.5% Bromo Cresol purple solution (BCP)
16) Phenophthalein indicator
17) Diethyl ether
18) Sodium Bicarbonate
19) Nitric acid
20) Sugar

2)Apparatusrequired*:* Test tubes, test tube holder and stand, dropper, gas burner, tripod stand, beaker, measuring cylinder, water bath, whatmann paper, and other laboratory equipments.

A. Sampling

1) Collection of sample: Milk sample were collected from dairy owners and local vendors.

TABLE 2. COLLECTION OF SAMPLES FROM DIFFERENT SOURCE

Sr. No.	Sample source	Marked As.
1	Packaged sample1	Sample 1
2	Local vendor1	Sample 2
3	Packaged sample2	Sample 3
4	Local vendor2	Sample 4
5	Packaged sample3	Sample 5
6	Local vendor3	Sample 6
7	Local vendor4	Sample 7
8	Local vendor5	Sample 8

2)Preparation of samples:
*Heat the milk sample.
*Stirr slowly for proper homogenization.
*Allow the sample to come to room temperature.

Figure 1 Heating the milk sample

3. METHOD:

1.Water

- Place a drop of milk on a slanting surface.
- Pure milk leaves a white trail behind whereas adultered milk will leave no trace.

2.Sugar

- Take 5 ML milk sample in a test tube add 1 ML concentrated HCL and 0.1 g resorcinol to it put it in water bath for 5 Min
- If red color appears it indicates the presence of added sugars.

3.Starch

- Take 3 ML of milk sample and boil it thoroughly and let it become normal to room temperature. Then add 1drop of 1% Iodine solution.
- Presence of starch gives blue color.

4.Common salt

- Take 5 ML of milk sample in a test tube and add 1 ML of 0.1 N silver nitrate solution. mix well and then add 0.5 ML of 10% Potassium Chromate solution.
- Milk free from added salt gives brick red color whereas yellow color indicates the presence of salt as an adulterant.

5.Hydrogen Peroxide

- Take 1 ML of milk sample and add 1 ML of potassium-Iodide-Starch reagent solution and mix thoroughly.
- Blue color indicates the presence of hydrogen peroxide in milk.

6.Formalin

- Take 5 ml milk sample in a test tube and add 2.5 ml concentrated H_2SO_4 with a little amount of ferric Chloride without shaking.
- If violet or blue color is observed at the junction of 2 liquid layers then formalin is present in milk sample.

7.Ammonium sulphate

- Take 4 ml of milk in a test tube and then add 1 ml NaOH (2%), 1 ml Sodium Hypochlorite(2%), 1ml Phenol (5%). Heat for 20 seconds in water bath.
- Appearance of bluish color shows presence of adulterant whereas pure milk gives light pink color.

8.Sulphates

- Take 5ml of sample and add 5 ml TCA solution filter through whatmann filter paper. Take 5 ml of filtrate and add few drops of barium Chloride solution
- Formation of milky white precipitate shows the presence of sulphates in milk.

9.Urea

- Take 5 ml of milk sample and then add equal amount of TCA solution. Take 2 ml of the filtrate and add 1 ml Sodium Hypochlorite (2%), 1 ml Sodium Hydroxide (2%) and 1 ml Phenol (5%) mix well.
- Pure milk remains colorless whereas adultered milk shows a characteristic blue or bluish green color.

10.Nitrate

- Take 2 ml of milk in a test tube then rinse it and drain the milk from test tube. Add 2-3 drops of reagent with dropper along the sides of test tube.
- Blue color shows presence of Nitrates.

11. Benzoic acid and salicylic acid

- Take 5 ml milk sample in a test tube and add few drops of Sulphuric acid. Dropwise 0.5% Ferric chloride solution is added to it.
- +Appearance of buff color shows that Benzoic acid is present whereas violet color indicates the presence of salicylic acid.

12.Detergent

- Take 5 ml of sample and then 0.1 ml bromo cresol purple solution is added to it.
- Violet color shows the presence of detergent in milk.
- Lathers forms when milk is mixed with equal amount of water and shake.
- This shows presence of detergent.

13.Soap

- Take 5 ml of sample and an equal amount of hot water is added to it. Add 1-2 drops of Phenolphthalein indicator.
- Presence of soap is inferenced when pink color appears.

14.Coloring matter

- Take 5 ml sample in a test tube. Add equal amount of Diethyl ether. After shaking nicely allow it to stand without disturbing.
- Appearance of yellow color in etheral layer shows addition of color to the milk.
- Add few drops of HCL to milk sample.
- Pink color shows presence of Azo dyes.

15.Skim milk power

- Add Nitric acid into the sample dropwise.
- Development of orange color shows milk is adultered.

16.Vanaspati

- Take 3 ml of sample and add 10 drops of HCL 1 tablespoon sugar is added and examined after 5 min.
- Red coloration indicates the presence of vanaspati.

4. OBSERVATIONS:

This chapter contains observation table for the tests performed and the results are discussed. The rapid qualitative tests discussed in previous chapter were performed to detect adulteration in the milk samples. 8 milk samples were collected from local vendors(unpackaged) and retailers(packaged) of pink city-Jaipur (Rajasthan).

TABLE 3.1. OBSERVATION TABLE FOR THE DETECTION OF SUGAR

Sample	Observation	Result
Sample 1	No red colour seen	Absent
Sample 2	No red colour seen	Absent
Sample 3	No red colour seen	Absent
Sample 4	No red colour seen	Absent
Sample 5	No red colour seen	Absent
Sample 6	No red colour seen	Absent
Sample 7	No red colour seen	Absent
Sample 8	No red colour seen	Absent

TABLE 3.2. OBSERVATION TABLE FOR THE DETECTION OF STARCH

Sample	Observation	Result
Sample1	No changes	Absent
Sample2	No changes	Absent
Sample3	No changes	Absent
Sample4	No changes	Absent
Sample5	No changes	Absent
Sample6	No changes	Absent
Sample7	No changes	Absent
Sample8	No changes	Absent

TABLE3.3. OBSERVATION TABLE FOR THE DETECTION OF COMMON SALT

Sample	Observation	Result
Sample1	Yellow colour observed	Present
Sample2	Yellow colour observed	Present
Sample3	Yellow colour observed	Present
Sample4	Yellow colour observed	Present
Sample5	Yellow colour observed	Present
Sample6	Yellow colour observed	Present
Sample7	Yellow colour observed	Present
Sample8	Yellow colour observed	Present

TABLE 3.4. OBSERVATION TABLE FOR THE DETECTION OF SKIMMED MILK POWDER

Sample	Observation	Result
Sample1	Development of yellow colour	Absent
Sample2	Development of yellow colour	Absent
Sample3	Development of yellow colour	Absent
Sample4	Development of yellow colour	Absent
Sample5	Development of yellow colour	Absent

Sample6	Development of yellow colour	Absent
Sample7	Development of yellow colour	Absent
Sample8	Development of yellow colour	Absent

TABLE 3.5. OBSERVATION TABLE FOR THE DETECTION OF VANASPATI

Sample	Observation	Result
Sample1	No change	Absent
Sample2	No change	Absent
Sample3	No change	Absent
Sample4	No change	Absent
Sample5	No change	Absent
Sample6	No change	Absent
Sample7	No change	Absent
Sample8	No change	Absent

TABLE 3.6. OBSERVATION TABLE FOR THE DETECTION OF HYDROGEN PEROXIDE

Sample	Observation	Result
Sample1	No blue colour seen	Absent
Sample2	No blue colour seen	Absent
Sample3	No blue colour seen	Absent
Sample4	No blue colour seen	Absent
Sample5	No blue colour seen	Absent
Sample6	No blue colour seen	Absent
Sample7	No blue colour seen	Absent
Sample8	No blue colour seen	Absent

TABLE 3.7. OBSERVATION TABLE FOR THE DETECTION OF FORMALIN

Sample	Observation	Result
Sample1	Violet colour not observed at junction	Absent
Sample2	Violet colour not observed at junction	Absent
Sample3	Violet colour not observed at junction	Absent
Sample4	Violet colour not observed at junction	Absent
Sample5	Violet colour not observed at junction	Absent
Sample6	Violet colour not observed at junction	Absent
Sample7	Violet colour not observed at junction	Absent
Sample8	Violet colour not observed at junction	Absent

TABLE 3.8. OBSERVATION TABLE FOR THE DETECTION OF AMMONIUM SULPHATE

Sample	Observation	Result
Sample1	Salmon pink colour forms& changes to blue gradually	Absent
Sample2	Salmon pink colour forms& changes to blue gradually	Absent
Sample3	Salmon pink colour forms& changes to blue gradually	Absent
Sample4	Salmon pink colour forms& changes to blue gradually	Absent
Sample5	Salmon pink colour forms& changes to blue gradually	Absent
Sample6	Salmon pink colour forms& changes to blue gradually	Absent
Sample7	Salmon pink colour forms& changes to blue gradually	Absent
Sample8	Salmon pink colour forms& changes to blue gradually	Absent

TABLE 3.9. OBSERVATION TABLE FOR THE DETECTION OF SULPHATES

Sample	Observation	Result
Sample1	No white ppt.	Absent
Sample2	No white ppt.	Absent
Sample3	No white ppt.	Absent
Sample4	No white ppt.	Absent
Sample5	No white ppt.	Absent
Sample6	No white ppt.	Absent
Sample7	No white ppt.	Absent
Sample8	No white ppt.	Absent

TABLE 3.10. OBSERVATION TABLE FOR THE DETECTION OF UREA

Sample	Observation	Result
Sample1	No change	Absent
Sample2	No change	Absent
Sample3	No change	Absent
Sample4	No change	Absent
Sample5	No change	Absent
Sample6	No change	Absent
Sample7	No change	Absent
Sample8	No change	Absent

TABLE 3.11. OBSERVATION TABLE FOR THE DETECTION OF NITRATES

Sample	Observation	Result
Sample1	No blue colour seen	Absent
Sample2	No blue colour seen	Absent
Sample3	No blue colour seen	Absent
Sample4	No blue colour seen	Absent
Sample5	No blue colour seen	Absent
Sample6	No blue colour seen	Absent
Sample7	No blue colour seen	Absent
Sample8	No blue colour seen	Absent

TABLE3.12. OBSERVATION TABLE FOR THE DETECTION OF BENZOIC ACID AND SALICYLIC ACID

Sample	Observation	Benzoic acid	Salicylic acid
Sample1	Buff colour seen	Present	Absent
Sample2	Buff colour seen	Present	Absent
Sample3	Buff colour observed with violet colour	Present	Present
Sample4	Buff colour seen	Present	Absent
Sample5	Buff colour seen	Present	Absent
Sample6	Buff colour seen	Present	Absent
Sample7	Buff colour seen	Present	Absent
Sample8	Buff colour seen	Present	Absent

TABLE 3.13. OBSERVATION TABLE FOR THE DETECTION OF DETERGENT

Sample	Observation	Result
Sample1	Faint violet colour seen	Absent
Sample2	Faint violet colour seen	Absent
Sample3	Faint violet colour seen	Absent
Sample4	Faint violet colour seen	Absent
Sample5	Faint violet colour seen	Absent
Sample6	Faint violet colour seen	Absent
Sample7	Faint violet colour seen	Absent
Sample8	Faint violet colour seen	Absent

TABLE 3.14. OBSERVATION TABLE FOR THE DETECTION OF SOAP

Sample	Observation	Result
Sample1	No pink colour seen	Absent
Sample2	No pink colour seen	Absent
Sample3	No pink colour seen	Absent
Sample4	No pink colour seen	Absent
Sample5	No pink colour seen	Absent
Sample6	No pink colour seen	Absent
Sample7	No pink colour seen	Absent
Sample8	No pink colour seen	Absent

TABLE 3.15. OBSERVATION TABLE FOR THE DETECTION OF COLOURING MATTER

Sample	Observation	Result
Sample1	No change	Absent

Sample2	No change	Absent
Sample3	No change	Absent
Sample4	No change	Absent
Sample5	No change	Absent
Sample6	No change	Absent
Sample7	No change	Absent
Sample8	No change	Absent

5. DISCUSSION: Results of these tests are summarized below in 3 tables focusing on edible adulterants, hazardous chemicals and different mixed adulterants.

TABLE 4.1. TEST RESULTS FOR THE DETECTION OF DIFFERENT EDIBLE ADULTERANTS

Sample no	Sugar	Starch	Common Salt	Skimmed milk powder	Vanaspati
1	Negative	Negative	Positive	Negative	Negative
2	Negative	Negative	Positive	Negative	Negative
3	Negative	Negative	Positive	Negative	Negative
4	Negative	Negative	Positive	Negative	Negative
5	Negative	Negative	Positive	Negative	Negative
6	Negative	Negative	Positive	Negative	Negative
7	Negative	Negative	Positive	Negative	Negative
8	Negative	Negative	Positive	Negative	Negative
% of + Results	**0%**	**0%**	**100%**	**0%**	**0%**

Above table reveals that all the milk samples contain common salt as an adulterant and are free from other edible adulterants (sugar, starch, skimmed milk powder and vanaspati).

Figure 2 Positive test results for the presence of Common Salts

Common salts are used to increase the SNF content falsely. Consumption of these excess salts is connected to hypertension, asthma, heartburn, etc.

TABLE 4.2. TEST RESULTS FOR THE DETECTION OF DIFFERENT HAZARDOUS CHEMICALS IN MILK

Sample no	Hydrogen Peroxide	Formalin	sulphates	Urea	Nitrate	Benzoic acid	Salicylic acid
1	Negative	Negative	Negative	Negative	Negative	Positive	Negative
2	Negative	Negative	Negative	Negative	Negative	Positive	Negative
3	Negative	Negative	Negative	Negative	Negative	Positive	Positive
4	Negative	Negative	Negative	Negative	Negative	Positive	Negative
5	Negative	Negative	Negative	Negative	Negative	Positive	Negative
6	Negative	Negative	Negative	Negative	Negative	Positive	Negative
7	Negative	Negative	Negative	Negative	Negative	Positive	Negative

8	Negative	Negative	Negative	Negative	Negative	Positive	Negative
% of Positive Results	**0%**	**0%**	**0%**	**0%**	**0%**	**100%**	**12.5%**

Tableshows us that hydrogen peroxide, formalin, sulphates, urea, nitrate are completely absent in all the milk samples. Presence of benzoic acid is found to be 100% whereas salicylic acid is present only in one sample that is sample no-3.

Figure 3 Positive test results for Benzoic acids as well as Salicylic acid

Benzoic acid & salicylic acid is used as preservative in the food industry. Past research showed that benzoic acid occurs naturally in milk and milk products as it is generated as by-product of microbial degradation of either hippuric acid or phenylalanine in dairy products[16].

TABLE 4.3. TEST RESULTS FOR THE DETECTION OF DIFFERENT MIXED ADULTERANTS IN MILK

Sample no.	Detergent	Soap	Coloring matter
1	Negative	Negative	Negative
2	Negative	Negative	Negative
3	Negative	Negative	Negative
4	Negative	Negative	Negative
5	Negative	Negative	Negative
6	Negative	Negative	Negative
7	Negative	Negative	Negative
8	Negative	Negative	Negative
% of Positive result	**0%**	**0%**	**0%**

All the 8 samples collected gave negative results for detergents, soaps and coloring matters.

6. CONCLUSIONS:

Milk adulteration is the social evil faced by the consumers. The evils of food fraud have spread vastly from many decades and is growing menace continuously in every field. Many scandals of milk adulteration occurred caused thousands of human deaths and serious health problems. So, one should know well about the products they are consuming as it can cause problems to their health. On the basis of above works and tests, results can be concluded in the below column, showing the adulterant present in different samples.

Water is considered as the most common adulterant. All the 8 samples showed the presence of common salt and benzoic acid in the milk as an adulterant and we know that benzoic acid occur naturally in milk & milk products at low concentrations. Common salts are generally used to increase the SNF (solid non-fat) content. Out of all the samples, only one sample contained salicylic acid as an adulterant used for preserving the milk for longer time. From the above results we can say that the milk consumption is quite safe in the Jaipur city whether bought from local vendors or the packaged samples showing only common salt as the adulterant in them.

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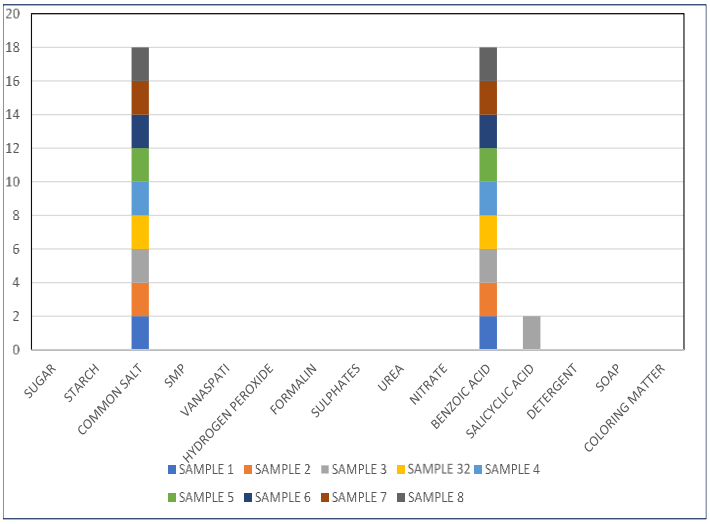

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Figure 4. Presence of various Adulterant in 8 different Milk Samples

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