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Detection of Adulterants in Several Food Commodities

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ABSTRACT: Food is one of the most essential and basic needs of all living beings. The objective of this study is to observe adulterants in commonly used food items. A right amount of food provides energy to survive, to do physical activity and to build body strength. Food without any adulteration such as addition of any unwanted chemical and substitution of nutritional quality is the need of all human beings. But with the developing world, adulteration with food has become very common by adding harmful chemicals to preserve food for longer periods or by removing or reducing the quality of food to gain profit. Such type of adulteration causes severe life threatening diseases. Knowing about such causes, many food companies still do adulteration and sell the product in market in the name of good quality and put consumers life in danger just to gain profit. In our study to detect adulteration in food items several chemical tests were performed.

KEYWORDS: Adulteration, Adulterants, Chemical tests.

I. INTRODUCTION

Adulteration of food commonly defined as “the addition or subtraction of any substance to or from food, so that the natural composition and quality of food substance is affected". Inferior or harmful substances are added to a food or product to increase its volume, weight, or appearance and for the sake for earning profit, thus making them unsafe for consumption or use. Food adulteration ultimately leads to various health risks. The Pharmaceutical adulteration refers to substituting or diluting medications with cheaper or harmful alternatives that decreases its efficacy and safety.

Adulteration means deterioration, admixture, sophistication, substitution, inferiority and spoilage. Deterioration is impairment in the quality of drug whereas admixture is addition of one article to another due to ignorance or carelessness or byaccident. Sophistication is the intentional or deliberate type of adulteration. Substitution occurs when some totally different substance is added in place of original drug. Inferiority refers to any substandard drug and spoilage is due to attack of microorganisms.[1]

Adulteration may be intentional or unintentional. The unintentional adulteration is usually due to ignorance, carelessness or lack of facilities for maintaining food quality.

Adulterant

The Adulterant means any material which is employed for making the food unsafe or sub-standard or mis-branded or containing any impurity matter.

TYPES OF FOOD ADULTERATION [2]

Intentional Adulteration: The adulterants are purposefully added to food to make it heavier and more profitable. Examples: - combining stone, sand, chalk powder, etc.

Incidental adulteration: This adulteration mainlyoccurs due to insufficient facilities to maintain the quality of food which includes inappropriate handling as well as packaging of food by the specified person. Examples of incidental adulteration are pesticide residue, dropping of the rodents, etc.

Metallic Adulteration: Adulteration with metallic materials, such as lead from water or mercury from effluents, can occur accidentally or on purpose.

Natural adulteration: This type of adulteration may occur due to the presence of different chemicals, organic food or naturally occurring food which are hazardous to health. Toxic varieties of pulses, green vegetables, fishes, etc are the different type of natural adulteration.

CAUSES OF FOOD ADULTERATION

Food adulteration is driven by a combination of economic, regulatory, and social factors.

Economic gain: Food adulteration is often done by unscrupulous traders or manufacturers to increase

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their profits by using cheaper or inferior quality ingredients. [3]

Lack of regulations: In some cases, weak enforcement of food safety regulations or lack of stringent laws can lead to food adulteration.[3]

Demand and supply gap: Sometimes, the high demand for certain food products can lead to adulteration as producers try to meet the demand quickly without proper quality control measures.[4]**Ignorance and lack of awareness:** Many consumers find it difficult to distinguish between pure and adulterated food items due to the lack of awareness. This lack of awareness allows adulterated items to infiltrate the market.[3]

METHODS OF FOOD ADULTERATION[1][5]

Substitution of exhausted drugs: This type of drug adulteration normally take place with costly drugs. Many drugs are extracted on large scale to isolate their active constituents or volatile oil. These exhausted materials are used entirely or partly as a substitute for the standard drugs.

Examples include: -

- Used tea leaves are collected dried and mixed with genuine drug and send to the market.
- Volatile oil containing drugs like caraway, fennel etc used to extract volatile oil by steam distillation then exhausted drugs are mixed with standard drugs due to similar appearance.

Adulteration by artificial substitutes: Artificial substitutes are prepared for some drugs which resemble with genuine drugs in form and appearance.

Example: Paraffin wax is yellow in colour and submitted for yellow beeswax.

Adulteration with other materials: In this type of adulteration, standard crude drugs are partially adulterated with other similar plant materials.

Examples include: -

- Black Catechu with Aloe
- Black Pepper with papaya seed
- Cinnamon cassia with C zeylanicum
- Mustard seeds with Argemone mexicana seed.

Adulteration with faulty collection: The optimum bioactive molecules are present in a crude drug at a particular season, time and age of plant. When the drugs are not collected during that specific period, the quality and quantity of the drug are reduced. When these drugs are mixed with standard drugs, they cause adulteration.

Examples include: -

- Clove buds are collected with stalks
- Buchu leaves and senega roots are collected with stems.

Adulteration due to imperfect storage: A number of drugs are spoiled due to imperfect storage or sometimes these are destroyed by the action of enzymes microorganism, moisture, light, temperature, etc. Thus, the drugs are not useful for human consumption. So, this type of drugs is considered as adulterant drug i.e., when cod liver oil is not protected light decomposition of vitamin A takes place. If volatile oils are not stored in well closed containers and not protected from the light and high temperature, evaporation of volatile constituents takes place.

Harmful adulterants: Sometimes wastes from the market are collected and it will be mixed with authentic drugs. This is mainly seen for liquids or unorganized drugs.

Examples include: -

- Pieces of amber coloured glass in colophony
- Limestone in asafoetida
- Lead shot in opium
- White oil in coconut oil

Addition of artificial colours: Some unscrupulous manufacturers may add artificial colours to food products to enhance their appearance.

Dilution with water or other substances: Adding water or other cheaper substances to food products can increase the quantity and reduce the cost for the manufacturer.

Mislabelling: Incorrect labelling of food products can mislead consumers about the ingredients or nutritional content of the product.

IMPACT OF FOOD ADULTERATION [3]

a. Health problems related to adulteration

Food adulteration has serious effects on our health. The addition of chemical adulterants and colours many times proves to be fatal. Some adulterated food may also affect our internal organs directly leading to heart, kidney, liver, and many more organ disorders and failure. Despite various measures taken by the government, spreading awareness about the hazards of food adulteration is a prevalent practice in many countries.

Immediate and Long-Term Impacts of Food Adulteration: -

- Immediate Effects: Nausea, vomiting, diarrhea, stomach pain, headache, and allergic responses.

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- Long-Term Effects: Serious health conditions such as cancer, heart disease, kidney illnessand liver disease.

b. Economic impact of food adulteration

Food adulteration leads to substantial economic losses at different levels. Consumers may suffer from health issues due to consumption of adulterated food, resulting in increased healthcare expenses. Also, food recalls and bans imposed on adulterated products can result in financial losses for food manufacturers and suppliers.

II. METHODOLOGY

II. i. TESTS FOR CHILLI POWDER

Samples used: Five samples were taken and labelled as A, B, C, D, and E. Among these, sample A is homemade, while the other samples (B, C, D, and E) were collected from the market, including both branded and loosely sold items.

PROCEDURE [6][7]

a. **To detect the presence of red lead salts:** Add dilute nitric acidto the sample of chilli powder. Filter the solution. Then add 2 drops of Potassium Iodide to the filtrate. Formation of yellow coloured precipitate indicates the presence of red lead salts.
b. **To detect the presence of brick powder:** Addchilli powder to a beaker containing chloroform. Brick powder settles down while pure chilli powder floats due to its lower density.
c. **To detect the presence of Rhodamine B:** Take2 g of chilli powder in a test tube. Then add 5ml of acetone. Immediate red colouration indicates the presence of Rhodamine B.
d. **To detect the presence of saw dust**: Add one teaspoon of chilli powder in a beaker containing water. Pure chilli powder floats while adulterated will settle down.[8]
e. **To detect the presence of Starch:** Add afew drops of iodine solution to chilli powder taken in a test tube. Appearance of bluish colour indicates presence of starch.[16]
f. **To detect thepresence of Sudan Red:** Add dilute nitric acid to a sample of chilli powder taken in a test tube. Filter it and in the filtrate add 2 drops of potassium iodide. As a result of which yellow colour precipitate is formed which indicates the presence of Sudan red.[16]

II. ii. TESTS FOR TURMERIC POWDER

Samples used: Five samples were taken and labelled as A, B, C, D, and E. Among these, Sample A is homemade, while the other samples (B, C, D, and E) were collected from the market, including both branded and loosely sold items.

PROCEDURE [6]

a. **To detect the presence of yellow lead salts**: Take 2 g of turmeric powder in a test tube. Add concentrated hydrochloric acid to it. The appearance of magenta coloration indicates the presence of yellow oxides of lead.
b. **To detect the presence of chalk**: Take 2 g of turmeric powder in a test tube. Add few drops of water followed by few drops of hydrochloric acid. Effervescence indicates the presence of chalk.
c. **To detect the presence of Metanil yellow:** Take a sample of turmeric powder. Add 13Nsulphuric acid to it. The disappearance of redcolour on adding distilled water indicates the presence of metanil yellow
d. **Detection of artificial colour in turmeric powder:** Add a teaspoon of turmeric powder to a glass of water. Natural turmeric powder leaves light yellow colour while settling down. adulterated turmeric powder leaves a strong yellow colour in water while settling down.[8]

II. iii. TESTS FOR CORIANDER POWDER

Samples used: Five samples were taken and labelled as A, B, C, D, and E. Among these, Sample A is homemade, while the other samples (B, C, D, and E) were collected from the market, including both branded and loosely sold items.

PROCEDURE [6]

a. **To detect the presence of dung powder:** Soak a sample of coriander powder in water. Dung or sawdust will float and can easily be detected by its foul smell.
b. **To detect the presence of common salt:** Take a sample of coriander powder and add 5 ml of water to it. Then add few drops of silver nitrate to it. The formation of white precipitate confirms the presence of salt.

II. iv. TESTS FOR MILK

Samples used: Five samples were taken and labeled as A, B, C, D, and E. Among these, sample A was collected directly from the source, while the other samples (B, C, D, and E) were collected from the market.

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PROCEDURE [9] [10]

a. **Detection of formalin in milk**: Take 5ml milk in a test tube. Add concentrated hydrochloric acid and ferric chloride to it. Place the tube in a water bath for 3-4 minutes. A positive result is indicated by brownish pink colour and negative result by white colour.

b. **Detection of salt in milk:** To 5 ml of milk in test tube, add 1 ml of 0.1 N silver nitrate solution and mix thoroughly. Then add 0.5 ml of 10% potassium dichromate solution. A positive result is indicated by a yellow colour and negative result by a red colour.

c. **Detection of maltodextrin in milk:** Add 5 ml milk to a test tube and then add 2ml Iodine reagent. Mix the contents well and observe for a color change. The positive result is indicated by a chocolate red colour and negative result by a slight yellow colour.

d. **Detection of sucrose in milk:** Take 1ml of milk in a test tube and add 2-3 drops of Molisch reagent. Then add 1mL of concentrated sulphuric acid through the sides of the test tube. A violet ring at the junction of the two layers indicates the presence of sucrose.

e. **Detection of cane sugar in milk:** Take5 ml of milk in a test tube, add 1 ml of concentrated hydrochloric acid and 0.1g resorcinol and mix. Place the tube in boiling water bath for 5 min and observe for colour change. A positive result is indicated by red colour and negative result by no colour change.

f. **Detection of starch in milk:** Take 3ml of sample in a test tube. After boiling it thoroughly, cool it to room temperature. Add 1 drop of 1% iodine solution. Appearance of blue color indicates the presence of starch.

g. **Detection of vanaspathi in milk:** In a test tube, take 5 ml of milk sample and add 10 drops of hydrochloric acid and 1 teaspoon of sugar. If the colour of the milk changes to red, it shows the presence of vanaspathi.

h. **Detection of Benzoic acid in milk:** Put 5mL of milk sample in a test tube. Acidify it with sulfuric acid, then add 0.5% ferric chloride solution. The presence of benzoic acid in milk is indicated by the appearance of buff colour.

i. **Detection of waterin milk:** Put a drop of milk on a polished slanting surface. The drop of pure milk flows, leaving a white trail behind it, whereas milk adulterated with water flows immediately without leaving a white mark.

j. **Detection of colouring matter in milk:** Add a few drops of hydrochloric acid to milk sample. The appearance of pink colour indicates the presence of azo dyes.

II. v. TESTS FOR COCONUT OIL

Samples used: Five samples were taken and labeled as A, B, C, D, and E. Among these, Sample A is homemade, while the other samples (B, C, D, and E) were collected from the market.

PROCEDURE [12]

a. **Determination of acid value**

Weigh accurately about 5g of sample into clean 250ml conical flask and add 25ml ethanol - ether mixture which has been previously neutralized with 0.1M potassium hydroxide to phenolphthalein indicator. If the sample doesn't dissolve in the solvent reflux for 10min with frequent shaking in a water bath. Add 1ml phenolphthalein indicator and titrate with 0.1M potassium hydroxide until the solution becomes pink colour. Calculate the acid value using the formula.

$$\text{Acid value} = \frac{\text{N}}{\text{w}} \times 5.61$$

where, N=no of ml of 0.1M potassium hydroxide required

w = weight of sample (g)

b. **Determination of saponification value**

Weigh 2g sample into clean round bottom flask and add 25ml of 0.5N ethanolic potassium hydroxide. It is then boiled in a reflux condenser for 60min.Cool the mixture to room temperature and add 1% phenolphthalein solution as an indicator to the cooled mixture and subsequently titrate against 0.5N hydrochloric acid until colour of mixture changes from pink to colourless. The volume of hydrochloric acid is recorded and repeated as S. Similarly, repeat the same for the blank and the volume of hydrochloric acid was noted as B.

$$\text{S} = \frac{(\text{B} - \text{S})}{\text{weight of sample(g)}} \times 28.05$$

Where, B -blank value
S-saponification value

II. v. TESTS FOR GHEE

Samples used: Five samples were taken and labeled as A, B, C, D, and E. Among these, sample A is homemade, while the others (B, C, D, and E) were collected from the market

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PROCEDURE [11]

a. **Detection of Starches (potato, sweet potato, other starches**): Take half a tea spoon of ghee and add two to three drops of tincture of iodine, if the ghee is adulterated with starch, then it gives blue colour.
b. **Detection of Palm Oil in Ghee:** To 2 ml of ghee add 1 ml Ferric chloride and 0.3 ml Potassium ferricyanide, for adulterated ghee the colour changes to blue.
c. **Detection of Coal Tar Dyes:** Take 5 ml dil. sulphuric acid to one tea spoon full of melted ghee sample. Pink colour indicates presence of coal tar dyes.
d. **Detection of Vanaspathy or Margarine in Ghee:** Take a tea spoon full of melted ghee in a test tube and add equal quantity of conc. sulphuric acid and add a little amount of sugar. Shake for a minute and leave aside for 5 mins. If colour changes to crimson it is due to presence of vanaspati/ margarine.
e. **Detection of Vegetable Oils:** Meltsome ghee andadd sugar into it. Shake it by closing container. If colour changes to red colour it shows the presence of vegetable oils.

II. vi. TESTS FOR HONEY

Samples used: Five samples were taken and labeled as A, B, C, D, and E. Among these, Sample A was obtained from a direct source, while the other samples (B, C, D, and E) were collected from the market.

PROCEDURE[8][14][15]

a. **Thumb test:** Put a small drop of honey on thumb and wait. If it is pure, it won't spread and spill out. If it spreads, then it's likely adulterated.
b. **Vinegar test:** Mix 2-3 teaspoons of vinegar with one tablespoon of honey along with some water. The formation of mixture indicates adulteration.
c. **Flame test:** Dip a dry matchstick in honey and try lighting it. If it lights up easily, it means that the honey is pure.
d. **Beaker test:** Pour some warm water into a glass, then add a spoonful of honey to it. The honey will settle down to the bottom if it is not adulterated.

III. RESULTS AND DISCUSSION

In the detection test for adulteration in chilli powder, we observed that brick powder and Rhodamine B was added as adulterant in sample B, C and D. Saw dust was detected in all the five samples.(Table1.1) In the case of turmeric powder, yellow lead salt (in B,C and E) and artificial colour (B and E) was found as adulterants(Table1.2) whereas chosen samples of coriander powder were found to be free from dung powder and common salt (Table1.3).

While detecting adulteration in milk, we found out that milk is being adulterated with sucrose, and water. Sample C and E was found to be adulterated with sucrose whereas C and D was found to be adulterated with water. (Table1.4).

According to Prevention of Food Adulteration Act, 1954 acid value of coconut oil should be not more than 6 and saponification value should be not less than 250[13]. All the 5 selected oil samples fall in this range which indicates that the selected samples are free from adulteration. (Table1.5).

In the tests for detection of adulterants in ghee starch is found as adulterant in sample B.(Table1.6).

It was observed that among all selected samples of honey, sample C is more adulterated compared to other selected samples.(Table1.7).

NOTE
+indicates adulterant is present/test is positive.
-indicates adulterant is absent/test is negative.

Table 1.1: Observations made during analysis of chilli powder

Adulterants	Samples				
	A	B	C	D	E
Starch	-	-	-	-	-
Red lead salts	-	-	-	-	-
Brick powder	-	+	+	+	-
Rhodamine B	-	+	+	+	-
Sudan Red	-	-	-	-	-
Saw Dust	+	+	+	+	+

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Table 1.2: Observations made during analysis of turmeric powder

Adulterants	Samples				
	A	B	C	D	E
Yellow lead salt	-	+	+	-	+
Chalk	-	-	-	-	-
Metanil yellow	-	-	-	-	-
Artificial color	-	+	+	-	+

Table 1.3: Observations made during analysis of coriander powder

Adulterants	Samples				
	A	B	C	D	E
Dung powder	-	-	-	-	-
Common salt	-	-	-	-	-

Table 1.4: Observations made during analysis of milk

Adulterants	Samples				
	A	B	C	D	E
Formalin	-	-	-	-	-
Salt	-	-	-	-	-
Maltodextrin	-	-	-	-	-
Cane sugar	-	-	-	-	-
Sucrose	-	-	+	-	+
Starch	-	-	-	-	-
Vanaspati	-	-	-	-	-
Benzoic acid	-	-	-	-	-
Water	-	-	+	+	-
Colouring matter	-	-	-	-	-

Table 1.5: Observations made during analysis of coconut oil

Test	Samples				
	A	B	C	D	E
Acid value	1.53	2.04	1.53	2.29	4.84
Sap. value*	405.5	294.5	279.2	386.3	317.5

*Indicates saponification value

Table 1.6: Observations made during analysis of ghee

Adulterants	Samples				
	A	B	C	D	E
Starch	-	+	-	-	-
Palm oil	-	-	-	-	-
Coal tar	-	-	-	-	-
Vanaspati	-	-	-	-	-
Vegetable oil	-	-	-	-	-

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Table 1.7: Observationsmade duringanalysis of honey

Test	Sample				
	A	B	C	D	E
Thumb test	-	-	+	-	+
Vinegar test	-	+	+	+	-
Flame test	-	-	-	-	-
Beaker test	-	-	+	-	-

IV. CONCLUSION

Food adulteration is a common cause occurring in all parts of the world to gain profit. As a result of the study, we found out a few adulterants in some of the popular as well as non popular brands. While detecting adulteration in spices we found out that chili powder is being adulterated with brick powder, rhodamine b and sawdust. Turmeric powder is being adulterated with yellow lead salts and artificial color. Dairy products such as milk and ghee which are used in almost all households on a daily basis are also adulterated. Milk is adulterated with sucrose and water whereas Ghee is adulterated with starch. Natural sweetener such as honey is also adulterated with sugar, water to enhance the sweetness and content. Edible oil such as coconut oil was also tested and found free of adulteration.

Our study revealed that food adulteration is a prevalent issue, affecting a significant portion of tested samples. As the method of adulterating food have become more sophisticated, very efficient and reliable technique for the detection of fraudulent manipulation are required.

So, to conclude we would like to point out that by staying informed, advocating for better regulation and promoting transparency, society can work towards a safe and healthier food supply.

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