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Research Article

QUALITY ASSESSMENT AND DETECTION OF ADULTERATION IN DIFFERENT BRANDS OF MANGO JUICE AVAILABLE IN INDIAN MARKET BY PHYSICOCHEMICAL METHOD

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ABSTRACT
Food adulteration is increasing worldwide and has taken the shape of dark web, where thousands of people are being killed daily due to poisoning or health hazard adulterants present in them. There are hardly any stringent regulations available for the punishment related to the food adulteration. The literature review revealed that, there is hardly any research work available on the fruit juice analysis. There is a lot to be unfolded related to the quality assessment of fruit juices. In the present study, different brands of Mango juice were collected and analyzed by various physical-chemical methods. Different parameters such as physical condition of a package, pH of juices, Refractive Index, presence of acids, sugars, Narcotic Drugs and psychoactive substance (NDPS) drugs, and alcohols were used to assess the quality. Narcotic drugs and alcohol content, was undetected in the given fruit juice samples, however, CO_2 was found to be higher in them. Sucrose found to be present within the given range in all the samples. In the present study, analysis had focused only on the physical and chemical methods. For future study, instrumental methods like high performance UV- Visible spectroscopy, liquid chromatography and Gas chromatography with mass spectrometer can be used to confirm the presence of adulterants in the suspected fruit juices.

Keywords: *Mango Juices, Food Adulteration, Food Quality, Food Assessment*

INTRODUCTION:

Fruits are important for the human health because it provides a large number of valuable vitamins, proteins and fibers. Commercially the fruits are available in many forms like juices, squashes, jams, jelly, chutneys, pickle, nectars, and frozen slices, etc. These products have extensive storing life span and they are delicious to eat (Kazi Sarower e*t. al.*, 2015). Some typical constituents of fruit are water (97 to 70), carbohydrate (25-3), proteins (95 to trace), lipids (25 to trace), acids (3 to trace), phenolic (0.5 to trace), dietary fibers (<1 to >15), vitamins (0.2 to trace), minerals (0.2 to trace), pigments (0.1 to trace). These values are dependent upon the fruits, cultivar, cultivation, and maturity and other factors (FAO Document Repository-food and agriculture organization of the United Nations.)Sometime manufacturer adds preservative such as Sodium benzoate to extend the life span of the product. The properly pasteurized juice has a life span of several months. The fruits like apple, mango, banana, kiwi, pineapple, etc. are mostly used to make commercial fruit juice products. The Manufacturing of these products is initiated by the process of washing and rinsing the fruits. The Juices extracted in a number of different ways i.e. steaming, reaming, pressing and pulping. Fruits pulped in a liquidizer; sugar added to fruit juices to make a fruit squash or cordial. Further samples have to filtered through suitable material mainly to remove the fine suspended particles then filled in a bottle and the filled bottles of the juices' pasteurized in a stainless steel or aluminum pan over a gas flame for 10-15 minutes. Both time and temperature of pasteurization need to be maintained in such way that it will attend its correct shelf life and it will retain the color and flavor of the juices (Fruit Processing Tool Kit).

The average growth rate of the juice market in India found to be 29% from 2009 to 2014. There has been a stable growth in the packed juice market for the last few years in India (Das S., 2016). Due to high population in India, there is a large demand of food in the market to fulfill all the necessities of the consumer. However, for the developing country like India, it is very difficult to provide the food to all its

consumers. So that the manufacturer has started the practice of adulteration in order to increase the quantity of the food products. In addition to that, the certain food products are more expensive. Sometime manufacturing industries are trying to manufacture the food products that are cheap in their price. These products need to maintain their quality in order to prevent certain events, which can be harmful to once life. Food greatly influences a health of the populations ;therefore, food quality control and quality assessment are an important government activity and need to be legislatively regulated. Food quality is a multifarious term that includes nutritional, sensory, hygienic-toxicological, and technological points of view. It is important to fulfill all requirements of quality, but above all, food has to be harmless and nontoxic in nature (Davídek, *No date*).

Food adulteration is an act of deliberately corrupting the quality of food offered for sale either by the admixture or by substitution of inferior substances or by the removal of some valuable ingredient. (food adulteration) Food adulteration is one of the chief problems faced by the buyers of India. There are several articles reported on the adulteration of various foods, i.e. ghee, milk, etc. (Jariwala & Pandey, 2015). Fruit juice adulteration is also one common type of adulteration found in India. The high cost of the fruit and the possibility of reduced harvests contradictory with high consumer demand, makes the fruit juice industry, as well as many other relatively high goods products vulnerable to human health and even for the environment (Marian Twohig *et al*. 2012). The most common forms of adulteration include simple dilution and addition of inexpensive and unnaturally produced juices into the more expensive ones. Most commonly used adulterant currently found in the fruit juices are inverted sucrose, wherein glucose and fructose produced by the hydrolysis of about one-half of the sucrose (analysis of fruit juices adulterated with medium Invert sugar from Beets, 2016). In addition to that, the juice dilution, the addition of high fructose corn syrup (HFCS) or the additional of other fruit juices (Marian Twohig, 2013) are also commonly practiced.

Fruit juices in India have to meet the standard given by the food safety standards authority of India (FSSAI). In the present study, manufactured Mango fruit juices were selected for their quality assessment, because Mango is one of the popular juicy fruit among the other popular juicy fruits like Orange, Grapes, Kiwi etc. This fruit belongs to the genus *Mangifera*. This is native to South Asia, from where the "common mango" or "Indian mango", *Mangifera indica*, has been distributed worldwide to become one of the most widely cultivated fruits in the tropics. Mango have shared the approximately 50% of market for among the all tropical fruits produced worldwide. Mangoes are also known as 'King of fruit'. There are some physical-chemical methods, which helps to find the adulteration in giving samples. This test includes test parameters like the physical condition of package, pH of juices, Refractive Index. Color test also help to find the specific compound such as carbohydrates, acids and alcohol. It is also possible that the juice samples are adulterated with narcotic drugs so that in this case Narcotics and psychoactive drugs (NDPS) drug test plays and important role in quality assessment.

MATERIALS AND METHODS

Sampling

In the present work, following commercially available six mango fruit juices were selected for analysis:
1) Minute Maid, 2) Priya Gold Treat Mango Masti, 3) Maaza, 4) Parle AgroFrooti Mango Drink, 5) Tropicana Fruitz Mango Swish, 6) Tropicana Slice etc.

Material

*Chemicals Used (Merck)***:** Iodine, Starch, Sodium Hydroxide, Distilled water, Conc. hydrochloric acid, Sodium bicarbonate, Copper Acetate, Sodium carbonate**,** Resorcinol, Sodium thiosulphate**,** Fehling's solution-A, Aniline chloride**,** Fehling solution-B, Selenious acid**,** Conc. Sulphuric acid, Copper Sulphate**,** Sodium hydroxide, Potassium Sodium tartrate**,** Sucrose (standard), $AgNO_3$**,** Dextrose(standard), Resorcinol, Fructose (standard), 40% formaldehyde**,** Acetic acid, aniline**,** Ammonia, Silver nitrate, SO_2 etc.

Apparatus: Lovibond Tintometer (WSL- 2), PH meter (Horiba Scientific, Laqua), J357 Refractometer-(Rudolph, Rudolph Research).

METHODS

All fruit samples were analyzed by the following tests:

Physical Examination:

The condition of packages: external condition of the Can such as rusty spots, body dents, scratches, leakage around seams, condition of the ends etc. were carefully observed. The results made by observing the features mentioned on the fruit juice cover, like FLAT (both ends concave), FLIPPER (a mechanical shock producing distortion in one end or both ends), SPRINGER (one end is distorted while the other end is flat) and SWELL (both ends convex). (Standard authority of India, 2012)

The color of the juice samples:

Tintometer was used to determine the color of the sample. The formula used to calculate the color reading given as follows:

Colour reading = (a Y + 5 b R) or (a Y + 10 b R)

Where, a = Sum total of the various yellow slides (Y) used.

b = Sum total of the various red (R) slides used.

Y + 5R is the mode of expressing the colour of light coloured sample.

Y + 10R is for the dark coloured sample (FSSAI, 2015)

Odour of the juice samples: The odour of the juice samples was physically examined and further noted done.

Acidity measurement by pH meter: A pH meter was used to determine the acidic or alkaline nature of the juice samples.

Refractive Index Measurement: The sample was introduced in a refractometer at 20 °C and readings for reflection were noted done; Based on the results obtained, the sucrose content was successfully calculated from the table given in figure 1.(I.S 1381:1993/ I.S.O 2173:1978 Fruit & vegetable products Determination of Soluble Solid Content, Refractometer method.)(FSSAI fruit and vegetable products, 2016)

Color Test

Test for the Presence of Acid: 5 mL of 20% NaOH solution added to the sample (0.1g). Results obtained were help to identify the aromatic acid or water, insoluble phenols, polyhydric phenols, Aminophenoneor benzoquinone, ammonium salts of acids, Chloral or it hydrates and Amides, amides, nitriles or urea etc.(Jazan University, Faculty of science, Department of Chemistry, Part I)**.**

Test for the presence of phenols: 1mL of conc. H_2SO_4 acid added to the sample (0.1g). Reaction was noted first while the mixture being cold and then after it gently warmed. The results obtained were help to identify the Citric acid and its salts, Carbohydrates, tartars, lactates and Phenols etc.(Jazan University, Faculty of science, Department of Chemistry, Part I)

Test for the presence of carbohydrates:

Test for the presence of starch: Few drops of Iodine solution added to the small amount of sample in a test tube. The blue color indicated the presence of starch.

Barfoed's reagent test: (Cu acetate in acetic acid): 1 mL of Barfoed's reagent was heated with 5 drops of sample in a boiling water bath. The results obtained were help to identify the Monosaccharides, Disaccharides and Polysaccharide.

Fehling's solution test: 3 mL of Fehling's solution added to the 1 mL of sample. The results obtained were help to identify the Reducing sugars and Non-Reducing sugars.

Benedict's test: 3 mL of Benedict's solution added to the 2 mL of sample, boiled for 2 minutes, and then cooled. The results obtained were help to identify the Reducing sugars and Non-Reducing sugars.

Tollens' Reagent test: 1 mL of Tollens' Reagent Solution was added to 1 mL of sample and heated genteelly. Results obtained were help to identify the presence of an aldehyde, aromatic aldehyde and alpha-hydroxy ketone functional groups.

Test for fructose: The dilute $CoCl_2$ solution added to a small amount of Sample, cool further added little ammonia solution. The results obtained were help to identify the presence of fructose and other carbohydrates.

Seliwanoff's Reagent: 1 mL of Sample was added to 4 mL of Seliwanoff's Reagent and further boiled on a boiling water bath for exactly 60 second. The Results obtained were help to identify presence of fructose, glucose and sucrose (Alaa.J.Mahrath)

Colour Test for Invert Sugars:

Aniline chloride test:

To 5 mg of sample, 2.5 mL of freshly prepared aniline chloride reagent was added while stirring. Within 1 min Orange-red colour turned to the dark-red.

Fiehe's test:

2 mg of sample was dissolved in 50 mL water and further extracted with diethyl ether in a funnel. Ether layer was collected in a porcelain basin and further evaporated. 4-5 drops of freshly prepared resorcinol solution were added. Appearance of cherry red colour obtained, proved the presence of invert sugar.(Jazan University, Faculty of science, Department of Chemistry, Part I)

Test for the Presence of Narcotic Drugs:

Duquenois Levine test: Duquenois Levine reagent added to the small amount of sample, further it was reacted with conc. HCL solution and $CHCl_3$. Violet colour obtained indicate the presence of cannabis.

Marquis reagent test: Marquis Reagent added to the small amount of sample. Purple violet colourobtained indicate the presence of Opium/crude morphine.

Mecke's test: Mecke's Reagent added to the small amount of sample. Deep green color obtained indicate the presence of Heroin (DFS narcotics Manual).

Test for the Presence of Alcohol:

Schiff's reagent test: Schiff's reagent added to the small amount of sample. Pink colour obtained indicates the presence of ethanol.

Iodoform test: To 1 mL of the distillate, a few drops of 10% NaOH, added until the solution became brown. A few drops of NaOH solution were added to this solution which had changed the color from brown to yellow. The precipitate formed after cooling was observed under Light microscope (DFS Chemistry Manual).

Table 1: Condition of package

SAMPLES	OBSERVATIONS			
	FLAT	**FLIPPER**	**SPRINGER**	**SWELL**
SAMPLE 1	NO	NO	NO	NO
SAMPLE 2	NO	NO	NO	NO
SAMPLE 3	NO	NO	NO	NO
SAMPLE 4	NO	NO	NO	NO
SAMPLE 5	NO	NO	NO	NO
SAMPLE 6	NO	NO	NO	YES

Refractive index	Soluble solids (sucrose) content	Refractive index	Soluble solids (sucrose) content	Refractive index	Soluble solids (sucrose) content	Refractive index	Soluble solids (sucrose) content
n_D^{20}	% (m/m)	n_D^{20}	% (m/m)	n_D^{20}	% (m/m)	n_D^{20}	% (m/m)
1,333 0	0	1,367 2	22	1,407 6	44	1,455 8	66
1,334 4	1	1,368 9	23	1,409 6	45	1,458 2	67
1,335 9	2	1,370 6	24			1,460 6	68
1,337 3	3	1,372 3	25	1,411 7	46	1,463 0	69
1,338 8	4			1,413 7	47	1,465 4	70
1,340 3	5	1,374 0	26	1,415 8	48		
		1,375 8	27	1,417 9	49	1,467 9	71
1,341 8	6	1,377 5	28	1,420 1	50	1,470 3	72
1,343 3	7	1,379 3	29			1,472 8	73
1,344 8	8	1,381 1	30	1,422 2	51	1,475 3	74
1,346 3	9			1,424 3	52	1,477 8	75
1,347 8	10	1,382 9	31	1,426 5	53		
		1,384 7	32	1,428 6	54	1,480 3	76
1,349 4	11	1,386 5	33	1,430 8	55	1,482 9	77
1,350 9	12	1,388 3	34			1,485 4	78
1,352 5	13	1,390 2	35	1,433 0	56	1,488 0	79
1,354 1	14			1,435 2	57	1,490 6	80
1,355 7	15	1,392 0	36	1,437 4	58		
		1,393 9	37	1,439 7	59	1,493 3	81
1,357 3	16	1,395 8	38	1,441 9	60	1,495 9	82
1,358 9	17	1,397 8	39			1,498 5	83
1,360 5	18	1,399 7	40	1,444 2	61	1,501 2	84
1,362 2	19			1,446 5	62	1,503 9	85
1,363 8	20	1,401 6	41	1,448 8	63		
		1,403 6	42	1,451 1	64		
1,365 5	21	1,405 6	43	1,453 5	65		

Figure 1: Refractive Index and the corresponding percentage by mass of solid content (Sucrose: FSSAI Fruits and Vegetable Products, 2016).

Table 2: Color, Odor and pH of the juice samples

SAMPLES	COLOR	ODOR	pH
SAMPLE 1	Yellow colour	Smell of mango	2 to 4
SAMPLE 2	Yellowish orange	Smell of mango somewhat different than above.	2 to 4
SAMPLE 3	Yellow colour	Smell of mango	2 to 4
SAMPLE 4	Orange yellow	Strong smell of mango	2 to 4
SAMPLE 5	Orange colour	Smell of mango	2 to 4
SAMPLE 6	Yellow colour	Strong smell of mango	2 to 4

Table 3: Sucrose Content in Juice on the basis of Refractive index

SAMPLES	REFRACTIVE INDEX	SUCROSE CONTENT
SAMPLE 1	1.35660	15%
SAMPLE 2	1.35574	15%
SAMPLE 3	1.35308	13%
SAMPLE 4	1.35328	13%
SAMPLE 5	1.35320	13%
SAMPLE 6	1.35243	13%

Table 4: Test for the presence of acid, phenols, NDPS drugs and ethanol

Sample	Acid	Phenol	NDPS Drugs	Ethanol
SAMPLE 1	Present	Present	Absent	Absent
SAMPLE 2	Present	Present	Absent	Absent
SAMPLE 3	Present	Present	Absent	Absent
SAMPLE 4	Present	Present	Absent	Absent
SAMPLE 5	Present	Present	Absent	Absent
SAMPLE 6	Present	Present	Absent	Absent

Table 5: Color test for the presences of carbohydrates

Sample	Starch	Glucose	Fructose	Non-reducing sugar	Invert Sugars
SAMPLE 1	Present	Present	Present	Absent	Absent
SAMPLE 2	Present	Present	Present	Absent	Absent
SAMPLE 3	Present	Present	Present	Absent	Absent
SAMPLE 4	Present	Present	Present	Absent	Absent
SAMPLE 5	Present	Present	Present	Absent	Absent
SAMPLE 6	Present	Present	Present	Absent	Absent

RESULTS AND DISCUSSION

As per the table No-1, Sample no-1 to sample no-5 were found to be in good conditions, however, in Sample no-6 packet cover swelling was observed. From this it was proved that, there might be some changes in the Sample No-6. From table No-2, It was observed that, the color of the juice samples was throughout the same, except for the Sample no-4 and the Sample no-5. This could be due to the different variety of mango used in the production of juices or due the presence of color additives which was intentionally added by the different juice product brands. Sweet mango odor was observed in all the mango juice samples. All the samples were analyzed and their pHs was measured, and it was found between the range of 2 to 4. Thus, it was concluded that, all the samples were found to be acidic in nature. From the table no- 3, refractive index of the juice samples was determined, and it was found in the range of 1.35243 to 1.35660 and from these values total content of sucrose was determined from the figure No-1, referred from FSSAI manual of Fruits and Vegetables. Total 15% of sucrose content was calculated successfully in Sample No- 1 and Sample No- 2, whereas total 13% of sucrose content was successfully calculated in Sample No-3 to Sample No-6. The yellow brown color obtained confirmed the presence of carbohydrates. The blackening of samples had confirmed the presence of phenols in all the samples. It was considered as a qualitative test for phenol. In this test, no pink color formation observed in any of the samples so that ethanol was undetectable in juice samples.

For carbohydrate analysis as per the table No-5, the blue-black color formattion in the sample hadconfirmed the presence of starch. The red precipitation formation had confirmed the presence of disaccharide such as fructose, glucose, sucrose etc. in all the samples. The yellow red precipitation formation had confirmed the presence of reducing sugar of fructose, glucose in all the samples in all the samples. In this, the red precipitation formation of Cu_2O had confirmed the presence of reducing sugar. Thus, this test had confirmed the presence of fructose; glucose in all the samples. The formation of mirror at the bottom of the test tube had confirmed the presence of the aldehyde group. Thus, this test confirmed the presence of Fructose and Glucose and Sucrose. The violet purple color was observed in all the samples, which had confirmed the presence of Fructose in all samples. The pink red color formation had confirmed the presence of Fructose.

CONCLUSION

From the present study, it was concluded that, each method used for analysis had its own importance. In the present work, more effort had given over the concentration of sugars in the Juice sample. From the physical examination of juice, samples adulteration of juice could not have identified clearly. The percentage of sucrose present in the juice sample was successfully identified by refractometer method. It was found that, almost all the samples contained same amount of sucrose. From the color test of the juice samples, it was concluded that, carbohydrates and acid were present in the juice samples. NDPS drugs and alcohol were undetected in the given juice samples. It was concluded that, the researchers can use these methods for juice samples analysis at preliminary level.

In future, instrumental method such as UV visible spectroscopy will help in the further determination of the adulterant in the juice sample. EDXRF will also help to determine the possible heavy metal adulterant or contamination present in the Juice sample. It is also possible to study the preservatives and other nutritional elements, which are present in juice sample by HPLC, ICP-MS and advance polarimeter. The present study is highly useful to the scientists working in Food Laboratory as well as in Forensic Science Laboratories for the analysis of juices.

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