Food quality during Covid-19 pandemic in south India: Consumer survey and DART (Detect Adulteration with Rapid Test) Analyses

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Abstract:

Ensuring the availability of high-quality food is always challenging, especially for developing countries like India. Long-term lockdown, shortages of staff and restrictions on transportation during the Covid-19 pandemic are anticipated to show a major impact on the country's overall food supply chain, which in turn may affect the quality of food. Therefore, It is highly important to find out the true conditions of food quality during the Covid-19 pandemic.

In this current work, two methods were adopted for the purpose; a) An online consumer survey was conducted to know the consumers' perception about food quality in south India during the pandemic. 180 Responses were collected from 5 states of South India using random purposive sampling technique and were analysed using descriptive analytical tools. Majority of the respondents complained about the worsening of the quality of milk and dairy products. Survey also revealed that quality issues are more frequently encountered in cities and with the foods procured from unorganized sectors. b) DART analyses were performed on 130 food samples, which were randomly collected from parts of Andhra Pradesh, Telangana, Karnataka and Kerala. Results showed that overall 41.5% of those tested samples were adulterated in one way or the other. Beverage like coffee powder samples were found to be most frequently adulterated (100%). Occurrence of adulteration was more in Andhra Pradesh compared to other states of study. However, no trends could be seen that loose products are always more adulterated compared to their branded counter parts.

Keywords: Food quality, Survey, Consumers' perception, DART analyses

1. INTRODUCTION

Food is extremely important for the growth of the human body and a major determinant of health. Food quality is one of the most important and major requirements in the manufacturing process as consumers are more susceptible to toxic substances (Potter, 1995). Therefore, it is essential to know that the food we consume is of good quality and safe. One of the major reasons for significant quality loss in food is Food Adulteration. According to the Food Safety Standards Authority of India (FSSAI), "Food adulteration" is an act of intentionally debasing the quality of food offered for sale either by admixture or substitution of inferior substances or by the removal of valuable ingredient". Unintentional adulteration may also happen during the preparation, storage and transportation of food, when foreign substances get added because of ignorance, poor hygiene and lack of infrastructure. Food adulteration is a global issue and affects almost all classes of raw and processed foods, such as, milk and dairy products, ghee (butter oil), mustard oil, olive oil, cereals, grain flour. The most common food adulterants are urea, starch, chalk powder, clay particles, insect infestations, dropping of the rodents, pesticide residues, exhausted seeds and undesired oils. These adulterants result in multiple health issues with instantaneous symptoms to chronic diseases and even may become fatal. There have been numerous incidents of food adulteration reported worldwide, possibly the first documented one is the Swill Milk Scandal in New York in 1850 where nearly 8000 children died in one year due to the consumption of swill milk (The New York times,1858).

Although India has seen many incidents of food adulteration since the Independence, the Covid-19 pandemic has brought into unprecedented situation in the food industry. The food supply chain got disrupted (Hobbs.J.E, 2020) and resulted in a striking imbalance in the demand and supply ratio. It can be anticipated that in order to adjust to this continuous shift of the demand-supply ratio, issues of adulteration will increase. Literature review and newspaper reports have also shown a growing number of cases of food adulteration, food frauds and quality issues in the past two years. The situation apparently got worse even more in South India where food adulteration was not common even a decade ago. Therefore, it is highly important to have a thorough understanding or assessment of the problem, such as which type of food is getting more frequently adulterated, what are the major adulterants being used, whether there is any specific region or sector which is more affected, etc.

This communication reports about the quality of food in south India during Covid-19 pandemic with the help of an exploratory consumer survey and DART analyses, a home based detection test for adulterants.

2. METHODOLOGY

2.1. Survey

The exploratory survey was carried out using a well designed questionnaire which was framed using Google Form and contained 11 sections starting with demographic information followed by consumers experience on food quality in different food groups. Randomised purposive sampling technique was used for the data collection. People aged 18 and above and residing in any of the five states of South India at least for the last 5 years were chosen as the target group. The collected data was fetched automatically from the Google Form to an MS-Excel worksheet. After careful manual screening, 180 valid responses were acquired which were used as raw data for all further analyses. Descriptive analyses such as bar diagram, pie charts were used as the statistical tools. Those were represented by graphical and pictorial methods.

2.2. DART analyses

A total of 130 samples belonging to different food groups were collected from Andhra Pradesh, Telangana, Karnataka and Kerala and tested for common adulterants using "Detect Adulteration with Rapid Test (DART)" protocols, developed and recommended by FSSAI. Samples were collected from both the organized (branded products from supermarkets) as well as unorganized (local retail stores, local farms, local vendors) sectors.

3. RESULTS AND DISCUSSION

3.1 Consumers' perception on Food quality during Covid-19

After analysing the responses of all 180 participants, it was found that majority of the respondents (22.8%) feel that quality of the milk and dairy products deteriorated during Covid-19. Another (20.3%) of the respondents feel the same about fruits and vegetables (Figure 1). Comparatively lesser percentage of respondents feel that quality of food grains and flours (13.5%), sugars and honey (13.2%), spices and salts (11.3%), beverages (8.8%), pre-cooked food (7.3%) and animal-based foods (2.8%) has gone down.
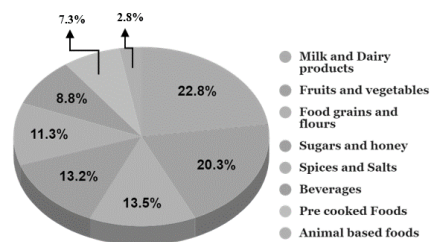

Figure 1: Consumers' perception about worsening of the quality of different food groups during Covid-19.

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The survey responses were further scrutinized to understand what was the major issues with each food group which bothered the consumers the most during the pandemic. For milk and dairy products (Fig.2 A), majority of the respondents complained about excessive dilution of the milk with water (76.3%) followed by presence of excess solid in the milk (14.2%), slimy yellowish paneer (14.0%) and unusual taste in ghee (13.3%). Only few respondents complained about bitter test of milk and its products (5.2%) and foamy appearance of milk (3.9%). The most plausible reason behind this type of experience may be that majority (75.5%) of the respondents who complained about low quality milk, used loose milk purchased from unorganized sectors (local dairy farms, milk vendors) (Fig.4 A) where monitoring of the safety compliances is challenging and scope of adulteration is much higher. For the fruits and vegetables (Fig.2 B), the major issue reported was excessive shiny appearance of fruits and vegetables, i.e., wax coating of fruits and vegetables (60.7%) and non-uniform ripening (19.6%). Here also the most possible reason of such findings is majority of the respondents who reported poor quality of fruits and vegetables, purchase those from unorganized sectors (88.0%) such as local vendors and farmers (Fig.4 B). This finding again manifests the challenges involved in maintaining quality compliance in unorganized sectors. The biggest quality issues reported for the food grains and flours (Fig.2 C) were presence of foreign substances such as dust, bran and small stones (56.5%), addition of artificial colours (17.1%) and insect infestation (13.1%). Similar to our earlier observations with milk and dairy products and fruits and vegetables, here also majority (54.8%) of these respondents, who reported poor quality grains, procured the grains from unorganized sectors (Fig. 4 C). This perception of the consumers about grain quality is in agreement with the article published in 2015, where the authors found that majority of the tested cereal and cereal products in coastal Andhra Pradesh are adulterated in one or the other way (Sudheer & K, 2015).
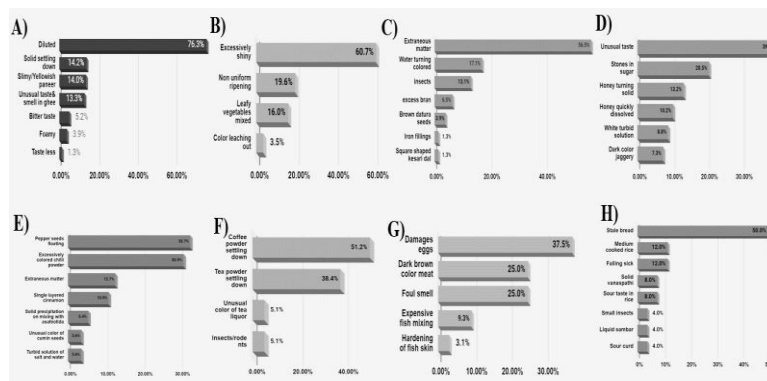

Figure 2. Quality issues reported for Milk and Dairy products (A), Fruits and Vegetables (B), Food grains and Flours (C), Sugars and Honey (D), Spices and Salts (E), Beverages (F), Animal based foods (G) and Pre-cooked foods (H).

Regarding sugar and honey (Fig.2 D), majority of the respondents reported about unusual taste (39.7%), presence of stones in sugar (20.5%) and unusual solidification of honey (13.2%). Here too, the respondents mostly purchased honey and sugar from unorganized sectors (48.1%) (Fig.4 D). The major complains which the respondents had about spices and salts (Fig.2 E) were presence of extraneous matter, colour leaching, mixing of whole spices with similar 29 looking cheaper seeds, presence of dust and chalk powder. Here also, majority of the respondents purchased those spices from unorganised sectors (60.3%) (Fig.4 E). Being asked about their experience on the beverages (Fig.2 F), majority (51.2%) of the respondents complained about coffee powder settling down at the bottom of the utensils which suggests presence of chicory powder or clay particles. Here again, majority of the respondents purchased those coffee powders from unorganised sectors (66.3%) (Fig.4 F). The major complaint which the respondents had about the pre-cooked foods served in food camps and Anganwadi centres were the serving of stale/old bread (50.0%), sour test of rice and curd (23.0%). Also 11 % of the respondents, who ate pre-cooked food during the pandemic, fell sick soon after the consumption. According to the respondents, quality of the eggs deteriorated the most amongst all other animal-based foods. 37.5% of the respondents reported discovering multiple damaged eggs in the egg crate. Other problems were unusual brown colour (25.0%) and foul smell in meat (25.0%) suggesting improper, prolonged storage. Here too, the majority (88.6%) of the respondents who complained about poor quality of animal-based food, procured the food from unorganized sectors (Fig.4 G) As it has been discussed above that majority of the respondents who complained about consuming poor quality food during pandemic, procured those foods from unorganized sectors, attempts were also made to correlate the consumers' experience with their location i.e., urban vs. rural. As evident from Fig. 3, for all food groups the respondents, who reported poor quality, mostly belong to urban areas. The most possible reason behind this finding is that the people in the rural areas mostly consume locally produced foods, whereas, people in the urban area mostly rely on the food produced and transported from distant places. It is an established fact that the adulteration cases happen much more in frequency and severity when the manufacturer and the consumer are unknown to each other.
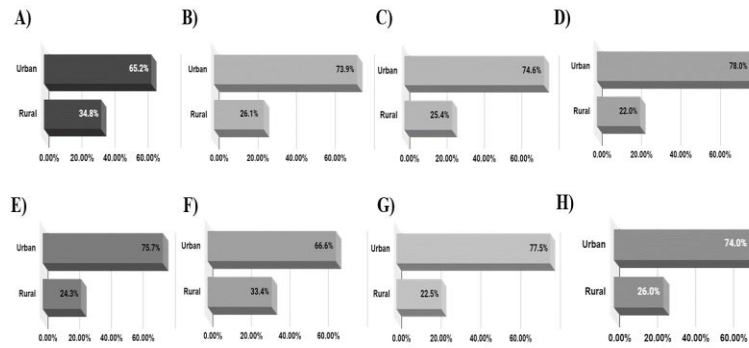
Figure 3. Location of the respondents who reported for Milk and Dairy products (A), Fruits and Vegetables (B), Food grains and Flours (C), Sugars and Honey (D), Spices and Salts (E), Beverages (F), Animal based foods (G) and Pre-cooked foods (H).
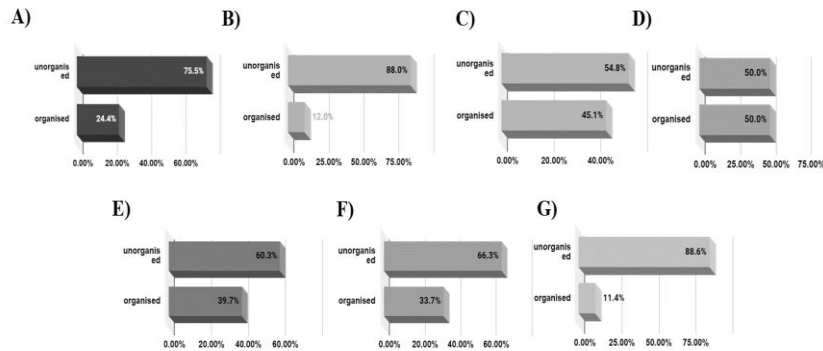

Figure 4. Procurement sources(organised vs unorganised) of the respondents who reported for Milk and Dairy products (A), Fruits and Vegetables (B), Food grains and Flours (C), Sugars and Honey (D), Spices and Salts (E), Beverages (F), Animal based foods (G) and Pre-cooked foods (H).

3.2 DART analyses (detect adulteration with rapid test)

A total of 130 food samples belonging to different food groups, were tested to detect presence of any common adulterants using DART protocols, as described under methodology. The pictures of all adulterated samples have been provided in the Supplementary material. Among those tested samples, 54 were found to be adulterated with one or the other adulterants, whereas, 76 did not contain any of the adulterants traceable by DART analyses. Table 1 summarizes the results of DART analyses for each food group. It was found that the problem of adulteration is most frequent among the coffee powder, where 10 out of 10 tested samples showed the presence of either clay or chicory powder. For other food groups, such as oils, salt and spices and sugar and honey the occurrence of adulterated products were relatively less; about half (45-50%) of such tested samples were found to be adulterated.

Table.1: Summary of results of DART analyses

Food Groups	No. of samples tested	No. of samples where adulteration was detected	No. of samples where adulteration was not detected
Milk and dairy products	20	6 (30.0%) *	14 (70.0%)
Oils	12	6 (50.0%)	6(50.0%)
Sugar and honey	19	7 (36.8%)	12 (63.1%)
Spices and salts	34	16 (47.1%)	18 (52.9%)
Food grains and flours	25	6 (24.0%)	19 (76.0%)
Fruits and vegetables	10	3 (30.0%)	7 (70.0%)
Coffee Powder	10	10 (100.0%)	0(0.00%)
Total	130	54 (41.5%)	76 (58.5%)

*The number in the parenthesis shows the corresponding % value. Example: For milk and dairy products, % of samples where adulteration was detected = (6/20) ×100 %

Milk and dairy products and fruits and vegetables were found to be the least frequently adulterated group, where, only 30% of the tested samples were adulterated. Surprisingly, this finding does not match with the respondents' perception found in our survey, where majority of the respondents complained about these two food groups.

Table 2 lists down the major adulterants found in DART analyses in each food group. Amongst the milk samples, only 2 out of 15 were found to be adulterated with excess water. Presence of more harmful adulterants, such as detergent and starch, were also not found frequently. Only 2 out of 15 tested milk samples contained detergent and starch. However, presence of starch in ghee was found to be quite common; 2 out of 5 ghee samples did not pass the iodine test. This

finding about ghee relates to an incident reported in December 2018 where a total of 15 desi ghee samples failed the purity test (The Tribune, 2018).

DART analyses on various oil samples revealed that contamination of coconut oil with other oils is a major issue, 6 out of 6 coconut oil were adulterated with other oils. However, no trace of TOCP could be found in any of the tested 12 edible oil samples. TOCP used to be a dangerous oil adulterant and caused many outbreaks in several parts of India during 1980-1990 (rudrajit paul, 2019). The current finding shows that it has been possible to control TOCP adulteration in both organized and unorganized sectors with the strict vigilance of FSSAI over the last couple of decades.

DART analyses of the honey and sugar samples indicated that the problem of adulteration is much more in honey as compared to sugar. Only 2 out of 11 tested sugar samples were contaminated with chalk powder, whereas, 5 out of 8 honey samples were found to contain sugar syrup. This result related to honey is in agreement with the recent study done by Centre for Science and Environment, India, where majority of the honey samples from famous brands in India turned out to be adulterated (CSE INDIA , 2020).

Among the salt and spices, the major quality issues detected by DART analyses were the presence of artificial colours and cheaper seeds, exhausted seeds. 10 out of 11 cloves and pepper samples were found to contain exhausted seeds and 3 out of 4 cinnamon samples were of compromised quality, suggesting the presence of cassia bark. This result is in agreement with the spice adulteration in Hyderabad, where 80 sacks of adulterated spices were seized and found several chemicals, paint and glue as adulterants in low grade spices. (Maheshbuddi, 2015)

Table 2: Major adulterants detected in each food type

Food	Test Done	No. of positive responses
Milk	Test to detect excess water	2 out of 15 (13.3%)
	Test to detect detergent	1 out of 15 (6.6%)
	Test to detect starch	1 out of 15 (6.6%)
Ghee	Test to detect starch	2 out of 5

		(40.0%
Oils	Test to detect other oils in coconut oil	6 out of 6 (100.0%)
	Test to detect TOCP in oil	0 out of 12 (0%)
Sugar		
	Test to detect Chalk powder	2 out of 11 (18.1%)
Honey	Test to detect Sugar syrup	5 out of 8 (62.5%)
Spices and salts	Test to detect Extraneous matter	1 out of 34 (2.9%)
	Test to detect artificial colours	2 out of 11 (18.1%)
	Test to detect Exhausted cloves/pepper	10 out of 11 (90.0%)
Cinnamon	Test to detect cassia bark	3 out of 4 (75.0%)
Food grains and flours	Test to detect extraneous matter	6 out of 25 (24.0%)
Fruits and vegetables	Test to detect Waxy coating	2 out of 2 (100.0%)
	Test to detect artificial Colours	1 out of 10

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		(10.0%)
Coffee powder	Test to detect Clay particles	4 out of 10 (40.0%)
	Test to detect Chicory powder	6 out of 10 (60.0%)

About a quarter (6 out of 25) of the tested grains and flours were found to be contaminated with extraneous matter, which may be the result of either intentional or accidental adulteration. This result is in agreement with the article published in 2015, where the authors found that majority of the tested cereal and cereal products in coastal Andhra Pradesh are adulterated in one or the other way (VSudheer & K, 2015).

Unfortunately, the results of DART analysis for fruits samples were not promising. 2 out of 2 apples, which were tested randomly, detected waxy coating on top of those. However, presence of harmful, artificial colours was not detected frequently in the tested vegetable samples. Only 1 out of 10 vegetable samples detected the presence of highly intense, artificial green colour.

Table 3: Occurrence of adulterated samples in each state

Food groups	Adulterated samples			
	Andhra Pradesh	Telangana	Karnataka	Kerala
Milk and dairy products	2 out of 15 (13.3%)	2 out of 15 (13.3%)	-	-
Oils and fats	6 out of 8 (75.0%)	0 out of 4 (0%)	-	-
Sugars and honey	6 out of 8 (75.0%)	1 out of 9 (11.1%)	0 out of 1 (0.0%)	0 out of 1 (0.0%)

Food grains and flours	4 out of 9 (44.4%)	2 out of 11 (18.1%)	0 out of 5 (0.0%)	-
Spices and salts	5 out of 9 (55.5%)	8 out of 17 (47.0%)	3 out of 4 (75.0%)	0 out of 4 (0.0%)
Fruits and vegetables	3 out of 4 (75.0%)	0 out of 5 (0.0%)	0 out of 1 (0.0%)	-
Coffee powder	5 out of 5 (100.0%)	3 out 3 (100.0%)	-	2 out of 2 (100.0%)

The samples tested by DART were collected mostly from Andhra Pradesh and Telangana. Table 3 shows the occurrence of adulterated samples in each state. It was found that, across most of the food groups, the occurrence of adulterated samples is higher in Andhra Pradesh compared to Telangana. Not only during the pandemic, but also before the Covid-19 pandemic, there were many cases reported on adulteration in Andhra Pradesh. According to one study conducted by FSSAI in 2015, Andhra Pradesh had the third highest number of food fraud cases in India after Gujarat and Madhya Pradesh (Reddy, 2017). They reported that about 20% of the 4,860 samples received and analysed at AP during 2015-16 were adulterated, which finally ended up with criminal and civil proceedings (Reddy, 2017).

Table 4: Occurrence of adulteration (detected by DART) in samples from organized and un-organized sectors.

Foods	Adulterated samples	
	Pre-packed/branded (from organized sector)	**Loose (from unorganized sector)**
Milk	4 out of 4 (100.0%)	0 out of 11 (0%)
Ghee	1 out of 3 (33.3%)	1 out of 2 (50.0%)
Oils	4 out of 8 (50.0%)	2 out of 4 (50.0%)

Sugars	1 out of 4 (25.0%)	1 out of 7 (14.2%)
Honey	2 out of 5 (40.0%)	3 out of 3 (100.0%)
Food grains and flours	0 out of 3 (0%)	6 out of 22(27.2%)
Spices and salts	4 out of 11(36.3%)	1 2 out of 23(52.1%)
Fruits	-	2 out of 3 (66.6%)
Vegetables	-	1 out of 7 (14.2%)
Coffee powder	5 out of 5 (100.0%)	5 out of 5 (100.0%)

As we found from the consumers' survey that food items procured from the unorganized sectors are more prone for adulteration and compromise in quality, we were curious to check whether DART analyses also reveal the same trend. Table 4 describes the occurrence of adulterated samples among samples from organized and unorganized sectors. It was true for ghee, honey, food grains, spices and fruits. However, milk and sugar samples from organized sectors showed more frequent adulteration. Oils and coffee powders from both organized and unorganized sectors showed similar occurrence of adulteration. Therefore, with this limited sample numbers, no definite conclusion can be drawn that samples procured from unorganized sectors are always more adulterated.

4. CONCLUSION

 Majority of the respondents complained about the quality deterioration of milk and dairy products (22.8%) followed by fruits and vegetables (20.3%), food grains and flours (13.5%). Dilution of milk with water, addition of artificial colour in the fruits and vegetables and presence of extraneous matters were reported to be the most common quality issues experienced with these three food groups. It was revealed that, for all food groups, the respondents who belong to the urban areas and purchase food from unorganized sectors encountered poor quality food more often compared to the respondents from rural area and purchase food form organized sectors.

DART analyses were carried out for 130 food samples randomly collected from different places of Andhra Pradesh, Telangana, Karnataka and Kerala. Milk and dairy products and fruits and vegetables were found to be the least frequently adulterated group, where, only 30% of the tested samples were adulterated. The major adulteration issues found in DART were presence of clay and chicory powder in coffee, presence of other oils in coconut oil samples and mixing of exhausted and cheaper quality alternative seeds in pepper and cloves. For most of the food groups, except milk, sugars and coffee powder, samples procured from unorganized sectors were found to be more adulterated or quality compromised than the samples collected from organized sectors

The project is not devoid of limitations. As DART can detect only limited adulterants by simple sensory evaluations, it cannot detect any complex adulterants which requires chemical analyses. Therefore, a sample which passes DART may still be adulterated. Samples from Tamil Nadu could not be procured for DART analyses due to restrictions on travel. Although the sample size for the survey was decent, yet a higher number of sample testing through DART will help to find the trends of food adulteration in a more accurate way. Therefore, as an extension of the current work, it is proposed to conduct the consumer survey all over India and perform DART analyses with samples uniformly collected from all 28 states and 8 union territories of the country.

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