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FOOD RISK ASSESSMENT OF PROCESSED FOOD PRODUCTS SOLD BY WOMEN FOOD BUSINESS OPERATORS IN TRIVANDRUM, KERALA

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Abstract

The healthy wellbeing of mankind depends mainly on the consumption of quality food. These days Self Help Groups (SHG) are implementing a large number of village cottage industries, especially food processing industries. The objectives of the study is to assess microbial quality of processed food items prepared by women food business operators. In this regard, 50 SHG women from ten vegetable and fruit processing units who are involved in food processing trade in Trivandrum and Kollam Districts, Kerala were selected for the study. The present study was undertaken to investigate the microbiological and chemical quality of ten most commonly processed and sold processed food items by women food business operators. One processed product from each unit were aseptically collected for conducting food risk assessment through microbial and chemical tests. Thus a total number of ten processed food items sold by these units were selected for conducting food risk assessment. The samples were analyzed by standard procedures within one day of procurement. Microbial analysis of the food samples revealed high loads of bacterial and fungal contamination. Results of the microbial test revealed that total bacterial count in nine samples varied between 18.5 - 159.5x10^4 cfu/ g and fungal contamination varied between 4.50 – 67.0 x 10^3 cfu/ g.

With regard to food risk assessment through chemical tests, it was found that only one product (lemon pickle) contained higher level of preservative than permissible limits and in four products (narunandi squash, nutmeg syrup, grape wine and jack fruit health tonic) it was seen that the total soluble solids content was lesser than the prescribed standards as per food safety regulations (FSSAI). The study highlights the need for conducting food risk assessment of small scale processing units, and also conducting awareness programmes for the food business operators for maintaining quality of processed foods.

Key words: Self help groups, food business operators, food risk assessment, FSSAI, processd product

I. INTRODUCTION

Food safety is a growing concern across the world. There is an increasing need to provide assurance about the safety and quality of food to consumers. Food safety has to be ensured at all stages of food chain from farm to fork. Our nutritional status, health, physical and mental faculties depend on the food ‘we eat and how we eat it’. Access to good quality food has been man’s main endeavour from the earliest days of human existence. Foods that are served to the consumers should be “clean and safe”. Food- borne diseases are a worldwide problem of great magnitude, both in terms of human suffering and economic costs. The task of accurate estimation of the occurrence of food -borne diseases globally is truly formidable as in most countries. It is estimated that almost 70 per cent of the approximate 1.5

billion episodes of diarrhoea that occur in the world annually are directly caused by biological or chemical contamination in food [11].

At present, in Kerala, self help groups (SHG) are implementing a large number of village cottage industries, especially food processing industries. In the absence of quality control measures, poor quality packaging material, improper transport of foods, use of contaminated water, high turn-over of food handlers, lack of personal hygiene and non judicious use of colorants and preservatives, these units pose considerable food safety hazards. The popularity of these foods among consumers clearly reflects an urgent need for stringent food safety regulations for these food processing units[12]. These systems not only provide new opportunities for the food industry but also put across challenges to ensure that these foods are wholesome and chemically and bacteriologically safe for human consumption [4].

In the recent years there has been marked increase in the consumption of food outside the houses. In developing countries poor environmental conditions prevails such as the lack of safe and sufficient water supplies, and inadequate facilities for the collection and the disposal of both solid and liquid wastes. It is from such environments that food handling personnel are often recruited. It is hardly surprising, therefore, when living under such conditions, that food handling personnel are not well versed in the importance of personal hygiene. Thus the need was felt to identify hazards posed to foods in different settings in the local situation so that the hazards could be minimized by taking corrective measures with respect to creating awareness and educating the food handlers. The objective of the study is microbial and chemical food risk assessment of fruit and vegetable processed items like jam, squash, syrup, pickles and dried/dehydrated products prepared by SHG's in Kerala.

II. MATERIALS AND METHODS

2.1.Selection of the study area and respondents

The study was conducted in Trivandrum district of Kerala State. Ten food processing units selling fruit and vegetable processed products were selected randomly from the list of processing units run by women self help groups maintained in the Trivandrum Corporation office. Fifty women 'food business operators' from the processing units were also selected randomly for the study.

2.2. Microbial Analysis

The items selected for microbial analysis were lemon pickle, grape squash, grape wine, narunandi squash, nutmeg syrup, mixed fruit jam, jackfruit halwa, narunandi syrup, jack fruit health tonic, and ginger lemon squash. These processed products were selected and subjected to microbiological evaluation within one day of collection. All the samples were collected in their own packaging materials and stored at ambient temperature. For the microbiological assay, 10/g or /ml of sample was weighed under aseptic condition, homogenized with 90 ml of sterile distilled water and mixed well (10^{-1} dilution). Serial dilutions were prepared and pour plate technique was used on appropriate selective media.

The selected food items for microbial analysis were brought to the laboratory under aseptic conditions, analyzed for total bacterial count on nutrient agar (NA), coliforms on Eosin Methyline Blue Agar (EMB), yeast and moulds on Potato Dextrose Agar with Rosebengal (PDA with RB), lactose fermenting and non fermenting organisms on Mac Conkey agar (Mac). Standard procedures were followed for microbial analysis with the above respective media. All plates were incubated under aerobic conditions at 36±1°C for 24-72 hrs. The mean number of colonies counted was expressed as log colony forming units (cfu)/10 per gram. Presence of coliforms was determined using Lauryl Tryptose Broth which is used for the detection of coliform bacteria in a variety of specimens. It is designed to obtain rich growth and substantial amount of gas from coliform organisms and Kovax reagent was used

for the indole production. Two to three characteristic colonies were labelled and transferred to lactose broth for further identification. After 24 hours, if gas production is observed, then biochemical tests were conducted for further confirmation and identification of the organisms.

2.3. Chemical Tests

The selected food samples such as lemon pickle, grape squash, grape wine, narunandi squash, nutmeg syrup, mixed fruit jam, jackfruit halwa, narunandi syrup, jack fruit health tonic, ginger lemon squash were subjected to chemical analysis such as acidity, moisture, TSS, preservatives and colours. Chemical analysis was done at the Government Food Analyst's Laboratory and the analytical results were compared with respect to prescribed standards as per regulation 2.12.1,3.1.2 (6) of FSS (Food Products Standards and Food Additives) Regulations 2011.

III. RESULTS AND DISCUSSIONS

3.1. Microbial Analysis

The selected processed foods were subjected to microbial analysis by serial dilution technique using different media like Potato Dextrose Agar with Rose bengal (PDA with RB), Nutrient Agar (NA), Eosine Methylene Blue Agar (EMB), and Mac Conkey (Mac). Data as presented in table I shows that maximum significant bacterial (159.5×10^4 cfu/ml) and fungal (67.0×10^3 cfu/ml) population was recorded in jackfruit health tonic. Products such as jackfruit halwa (130.5×10^4 cfu/ml), grape squash (127.5×10^4 cfu/ml) , narunandi syrup (127.0×10^4 cfu/ml), nutmeg syrup (127.0×10^4 cfu/ml), also recorded maximum bacterial population. And they are on par. The samples, mixed fruit jam and narunandi squash recorded bacterial population of 92.5×10^4 cfu / ml. The lowest bacterial population was recorded in lemon pickle (22.5×10^4 cfu/g) and ginger lemon squash (18.5×10^4 cfu/ml). The product grape wine was free from bacterial contamination. Next to jackfruit health tonic, the maximum fungal growth of 60.0×10^3 cfu/g was recorded in mixed fruit jam. The products like narunandi squash (50.5×10^3 cfu/ ml), jackfruit halwa (30.5×10^3 cfu/g), nutmeg syrup (29.5×10^3 cfu/ml), grape squash (28.5×10^3 cfu/ ml), narunandi syrup (25.5×10^3 cfu/ml), and ginger lemon squash (14.5×10^3 cfu/ml) also recorded fungal growth. The lowest fungal growth of 4.5×10^3 cfu/g was recorded in lemon pickle.

To detect the presence of coliforms, samples were also plated on EMB and Mac Conkey Agar. In EMB media, the maximum bacterial growth was recorded in mixed fruit jam (150.5×10^5 cfu/g), which was followed by grape squash (125.0×10^5 cfu/ml), nutmeg syrup (54.0×10^5 cfu/ml), narunandi syrup (28.5×10^5 cfu/ml) and jackfruit halwa (11.5×10^5 cfu/g). The lowest growth was recorded in jackfruit health tonic (3.5×10^5 cfu/ml) and narunandi squash (3.0×10^5 cfu/ml). The samples lemon pickle, ginger lemon squash and wine were free from bacterial growth in EMB media. The presence of maximum pink coloured, lactose fermenting colonies were recorded in Grape squash (92.5×10^5 cfu/ml). The samples like narunandi squash (16.0×10^5 cfu/ml), nutmeg syrup (40.0×10^5 cfu/ml), mixed fruit jam (11.5×10^5 cfu/g), jackfruit halwa (5.0×10^5 cfu/g), narunandi syrup (8.0×10^5 cfu/ml), jack fruit health tonic (20.5×10^5 cfu/ml) also showed pink coloured colonies.

Table 1. Total microbial count in selected processed food samples, cfu/ ml or g

Samples	Bacteria x(10^4)	Fungi x(10^3)	Total Coliforms (EMB x(10^5))	Growth on Macconkey x(10^5)	
				Pink	White
Mixed fruit jam	92.5[d]	60.0[b]	150.5[a]	11.5[e]	73.0[c]
Jackfruit health tonic	159.5[a]	67.0 [a]	3.5[e]	20.5[c]	28.0[f]
Narunandi syrup	127.0[bc]	25.5 [d]	28.5[d]	8.0[f]	48.5[e]
Nutmeg syrup	127.0[c]	29.5 [d]	54.0[c]	40.0[b]	57.5[d]
Grape squash	127.5[bc]	28.5 [d]	125.0[b]	92.5[a]	89.5[b]
Lemon pickle	22.5[e]	4.5 [f]	0.0[e]	0.0[h]	0.0[g]
Jackfruit halwa	130.5[b]	30.5 [d]	11.5[e]	5.0[g]	29.0[f]
Narunandhi squash	92.5[d]	50.5 [c]	3.0[e]	16.0[d]	95.0[a]
Ginger lemon squash	18.5[e]	14.5[e]	0.0[e]	0.0[h]	0.0[g]
Wine	0.0[f]	0.0[f]	0.0[e]	0.0[h]	0.0[g]
CD VALUE (0.05)	10.486	5.525	12.760	2.228	3.827

Table 2. Standard Specifications of lactose fermenting organisms

Organisms	Growth	Gas production	Indole production
Escherichia coli	**Good**	**+ve**	**+ve**
Enterobacter aerogenes	**Good**	**+ve**	**-ve**
Salmonella typhimurium	**Good**	**-ve**	**-ve**

Table 2 shows the standard specifications of lactose fermenting organisms. If gas production and indole production is positive, it can assumed that the organism is *Escherichia coli.* Similarly If there is gas production and negative indole production, the organism present is presumed to be *Enterobacter aerogenes.* When both gas and indole production are negative, it can be confirmed that the organism is *Salmonella typhimurium.*

Table 3. Results of presumptive test using lauryl tryptose broth

SAMPLES	GAS PRODUCTION	INDOLE PRODUCTION
Mixed fruit jam	+ve	-ve
Jackfruit health tonic	+ve	-ve
Narunandi syrup	+ve	-ve
Nutmeg syrup	+ve	-ve
Grape squash	+ve	-ve
Jackfruit halwa	+ve	-ve
Narunandi squash	+ve	-ve

Table 3 shows the results of presumptive test using lauryl tryptose broth, whether the organisms found in the samples were *E.coli* or not. The samples such as mixed fruit jam, jack fruit health tonic, narunandi syrup, nutmeg syrup, grape squash, jackfruit halwa and narunandi squash showed gas production and indole is negative. Hence the organisms found in the samples were assumed to be *Enterobacter aerogenes.* Inorder to confirm the results, biochemical tests were conducted.

Table 4. Biochemical characters of Enterobacter aerogenes

Characters	Results
Catalase	+ ve
Indole	-ve
Citrate	+ ve

The table 4 shows the biochemical characters of *Enterobacter aerogenes.* Since the samples were catalase positive, indole negative and citrate positive, it was concluded that the pink coloured colonies found in the samples were *Enterobacter aerogenes.* Thus, food risk assessment conducted on the products sold by these units through microbial analysis revealed presence of bacterial and fungal contamination in 9 out of 10 samples studied. *Enterobacter aerogenes* was detected in 7 samples.

Table 5. Classification of processed products based on criteria developed for microbial load

Extent of growth	Average colony count	Remarks	Results of ten products
No growth	0	Excellent	Wine
+	<30	Good	Lemon pickle, Ginger lemon squash
++	30 – 100	Satisfactory	Narunandi squash
+++	>100	Unsatisfactory	Mixed fruit jam, Jackfruit health tonic, Narunandi syrup, Nutmeg syrup, Jackfruit halwa, Grape squash
++++	Countless	Highly unsatisfactory	-

Based on criteria developed for microbial load of processed products only one product (Grape wine) was graded as excellent, while two products (Lemon pickle and Ginger lemon squash) were graded as good, one product (Narunandi squash) graded as satisfactory and 6 products (Mixed fruit jam, Jackfruit health tonic, Narunandi syrup, Nutmeg syrup, Jackfruit halwa, Grape squash) were graded as unsatisfactory [10].

Results of the microbial test revealed that total bacterial count in nine samples varied between 18.5 - 159.5x10^4 cfu/ g and fungal contamination varied between 4.50 – 67.0 x 10^3 cfu/ g. The bacterial count is high compared to fungi in selected food products. High degree of contamination in unprocessed foods and semi processed foods has been reported earlier [5]. A study on microbial quality of food products sold by SHG'S revealed low bacteria counts which may be the result of high standard of personal hygiene and quality maintenance of good manufacturing practices observed during the food formulation process [3]. The presence of microorganisms indicated contamination of the processing water as well as the prevailing unhygienic conditions related to the location of the food stalls and especially in dusty road side locations [8]. The presence of microbes in food can be linked to a number of factors such as improper handling and processing, use of contaminated water during washing and dilution, cross contamination from rotten fruits and vegetables, or the use of dirty processing utensils like knife and trays [2].

In the present study it was found that four units (40 per cent) were using well water for processing raw fruits and vegetables. It was also found that water purification measures were not followed regularly by these units also. This may be the reason for the high bacterial contamination of the products. In a study it was observed that bacteria from dirty dish washing waters and other sources can adhere to utensil surfaces and constitute a risk for contamination in foods [1].

Contamination of foods may also occur from improper storage, inadequate lighting, improper washing and cleaning of fruits and vegetables and processing utensils. In this study, it has been found

that proper drainage and waste disposal measures were available only in 30 per cent of the units while 70 per cent did not have proper drainage and waste disposal measures. The chances of contamination of food increase greatly due to extremely poor environmental condition in which they are prepared and served [7].

Defective personal hygiene can facilitate the transmission of these pathogenic bacteria found in environment and on people's hands via food to humans [9]. In a study on handlers hygiene practices in small restaurants of Vadodara it was found that most food handlers exhibited poor personal hygiene and poor personal habits. E. coli 0157:H7 was detected in two out of three knife samples and table mop cloth samples; Salmonella was detected in one of the table mops cloths and two hand towel samples, respectively. Two of the table mop cloth samples also indicated presence of Shigella [6]. In this study, it was also observed that eighty per cent of the units were not following proper food handling and hygienic practices. All these factors may be together responsible for the bacterial and fungal contamination of the products prepared in these units.

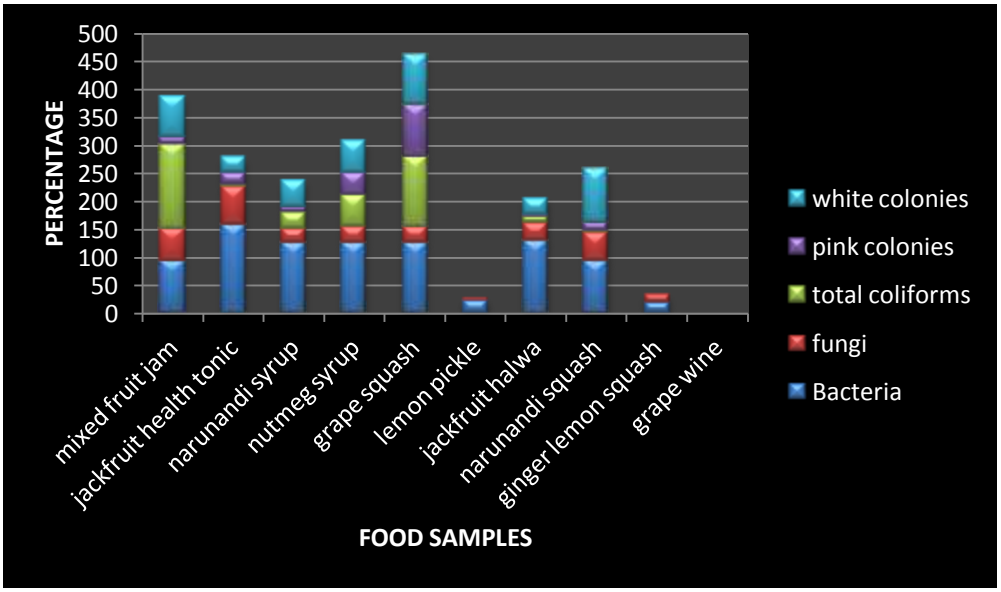

Figure 1. Percentage distribution of bacterial and fungal contamination in food samples

3.2. Chemical Analysis

Chemical analysis was done at the Government Food Analyst's Laboratory and the analytical results were compared with respect to prescribed standards as per regulation 2.12.1,3.1.2 (6) of FSS (Food Products Standards and Food Additives) Regulations 2011.

Table 6. Results of chemical analysis of selected processed food samples

FOOD ITEMS	QUALITY CHARACTERISTICS	NAME OF METHOD OF TEST USED	RESULTS	PERMISSIBLE LIMITS
Lemon pickle	Synthetic food colour	DGHS Method	Absent	-
	Mineral acid	DGHS Method	Negative	-
	Sodium chloride content	DGHS Method	7.52 per cent	-
	Oil soluble colour	DGHS Method	Absent	-
	Benzoic acid	IS:3501:1966	**1840.94 ppm**	**250.0 ppm**
	Acidity	IS 2860:1964	3.24 per cent	-
Grape squash	Total soluble solids	IS Method	53.7 per cent	40.0 per cent
	Saccharin	DGHS Method	Negative	-
	Acidity	IS 13844:2003	**1.23 per cent**	**3.5 per cent**
	Benzoic acid	ICMR Method	Negative	-
	Added synthetic food colours	ICMR Method	139.2 ppm	200.0 ppm
Grape wine	Total soluble solids	IS Method	22.8 per cent	-
	Saccharin	DGHS Method	Negative	-
	Acidity	DGHS Method	0.63 per cent	-
	Benzoic acid	ICMR Method	Negative	-
	Added synthetic food colours	ICMR Method.	Negative	-
	The alcoholic content	IS: 3752	23.2 per cent	-
Narunandi squash	Total soluble solids	IS Method	64.2 per cent	40.0 per cent
	Sugar content	DGHS Method	Positive	-
	Saccharin	DGHS Method	Negative	-
	Acidity	IS 13844:2003	**0.88 per cent**	**3.5 per cent**
	Added synthetic food colours	ICMR Method	Negative	-
Nutmeg syrup	Total soluble solids	IS Method	42.2 per cent	65.0 percent
	Sugar content	DGHS Method	Positive	-
	Saccharin	DGHS Method	Negative	-
	Acidity	IS 13844:2003	**0.8 per cent**	**3.5 per cent**
	Added synthetic food colours	ICMR Method	Negative	-
Mixed fruit jam	Total soluble solids	IS Method	66.4 per cent	65.0 percent
	Saccharin	DGHS Method	Negative	-
	Added synthetic food colours	ICMR Method	7.7 ppm	100.0 ppm
Jackfruit halwa	Saccharin	DGHS Method	Negative	-
	Sugar	DGHS Method	Positive	-
	Benzoic acid	DGHS Method	Absent	-
	Added synthetic food colours	ICMR Method	Negative	-
Narunandi syrup	Total soluble solids	IS Method	63.8 per cent	40.0 per cent
	Added synthetic food colours	ICMR Method	Negative	-
	Benzoic acid	ICMR Method	Negative	-
	Saccharin	DGHS Method	Negative	-
	Acidity	DGHS Method	0.86 per cent	3.2 per cent
Jackfruit health tonic	Total soluble solids	IS Method	22.5 per cent	65.0 per cent
	Added synthetic food colours	ICMR Method	Negative	-
	Benzoic acid	ICMR Method	Negative	-
	Saccharin	DGHS Method	Negative	-
	Acidity	DGHS Method	1.33 per cent	3.5 per cent
Ginger lemon squash	Acidity	IS 13844:2003	3.45 per cent	3.5 percent
	The sugar content	DGHS Method	Positive	-
	Saccharin	DGHS Method	Negative	-
	Total soluble solids	IS Method	49.4 per cent	40.0 percent

Table 6 shows the results of chemical analysis(Analysis data from Food Analyst lab, Kerala State) and it is revealed that the use of preservatives exceeding the prescribed limits was found only in one sample (lemon pickle), while TSS content was lesser than prescribed standards in 4 products like Nutmeg syrup, Mixed fruit jam, Narunandi syrup and jackfruit health tonic. In the case of acidity majority of the samples contained less acidity than permissible limits.

The chemical analysis results revealed that the use of preservatives exceeding the prescribed limits was found only in one sample (lemon pickle), which contained benzoic acid at the level of 1840.94 ppm, while the permissible limits of benzoic acid is 200 ppm as per the reccomandation of FSSI. TSS content was lesser than prescribed standards in 4 products like nutmeg syrup (42.2 per cent), mixed fruit jam (66.4 per cent), narunandi syrup (63.8 per cent) and jackfruit health tonic (22.5 per cent). In the case of acidity also, majority of the samples contained less acidity than permissible limits. With regard to grape squash (1.23 per cent), grape wine (0.63 per cent), narunandi squash (0.88 per cent), nut meg syrup (0.8 per cent), narunandi syrup (0.86 per cent), jackfruit health tonic (1.33 per cent) contained lesser acidity than prescribed standards.

Earlier the microbial food risk assessment showed that the lemon pickle is comparatively low in bacterial and fungal contamination, which may be due to the higher levels of preservative (benzoic acid) present. The use of preservatives in processed food products helps to delay or prevent microbial contamination and increase the shelf life of the products and retard the bacterial and fungal growth but the excess use of preservatives in processed products is harm to the health of humans who consume it. The jack fruit health tonic showed very high level of bacterial and fungul contamination, this is because of low level of TSS present as compared to the required level.

IV CONCLUSION

Food risk assessment conducted on the products sold by SHG's through microbial analysis revealed bacterial and fungal contamination in 9 out of 10 samples studied. *Enterobacter aerogenes* was detected in 7 samples. Based on criteria developed for microbial load of processed products only one product was graded as excellent, while two products were graded as good, one product graded as satisfactory and 6 products were graded as unsatisfactory. Chemical analysis revealed that the use of preservatives exceeding the prescribed limits was found only in one sample, while TSS content was lesser than prescribed standards in 4 products. It was also concluded that lack of proper infrastructure facilities, adequate waste disposal measures and the lacuna in the knowledge of the respondents with regard to appropriate processing methods of fruits and vegetables may be the reasons for the bacterial and fungal contamination in ninety per cent of the samples studied and also the indiscriminate use of preservatives.

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