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Consumption Pattern of Indian '*Chat*' Based Snacks and Formulation of Millet Based Snack '*Poories*'

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ABSTRACT

Whole grains have a long history of use in human diet. They are universally recommended as an important part of the diet as they are rich source of energy, carbohydrate, protein and fiber. The present study was carried out with an objective to determine consumption pattern of 'chat' based snacks, and to formulate millet based snack 'poories' used for 'chat'. The formulated products were evaluated for nutritional composition, sensory quality and storage stability. A control product (with whole wheat flour) and three sets of experimental products (with millet flour incorporation, 40% and 60% of either foxtail, sorg humor little millet) were prepared. Results showed that chat based snacks, mostly sold through street vendors were consumed frequently by the respondents. Control product had highest fat content (36.87g/100g), while others had lower range. Iron content ranged between 5.31-6.76mg/100g. Calcium was high on account of addition of an additive. Both free fatty acid and peroxide value were low in fresh products and in products stored under refrigeration for 7 days and a little higher at room temperature storage, however, it was still in acceptable range indicating good storage stability of formulated products. Most of the millet incorporated products were acceptable on par with control sample. In conclusion, millet flours can be incorporate while preparing snack 'poories' for health reasons.

Keywords: *Nutritional composition, sensory quality, storage stability, consumption pattern, snack foods.*

INTRODUCTION

The state of nutrition in world indicates major changes in the health scenario with increasing number of people suffering with lifestyle diseases both in developed and developing countries [1]. One of the major causes for these changes is the nutrition transition and nutrition insecurity impacting the overall health of population across all ages [2,3]. The changes in dietary pattern reflect increasing use of processed foods, fast foods, refined foods and frequent eating away from home. The practice of consuming traditional home cooked meals is less preferred especially among the young generation. With changing food habits, consumption of so called fast catered foods is becoming more common in urban and rural populations [4]. '*Chat*' based snacks are a very popular category of products consumed by young and old alike in India, specifically through street vendors. These are spicy dishes prepared fresh and eaten with different types of spiced toppings including lentils, vegetables and spice mixtures. Many of the *chat* based dishes make use of '*chat poories'*, which are small circular fried flat wheat breads eaten with many other spiced ingredients. These are pre-prepared staple packed items sold separately and used at the time of serving. These '*poories*' are generally prepared with wheat flour (whole and/ or refined) and wheat semolina and are calorie dense products.

Millets are considered as one of the most important staple crops which play a significant role in the food and nutrition security of developing countries especially India. The important millets crops that are being cultivated in India are; sorghum (*Sorghum bicolor*, great millet), pearl millet, (*Pennisatum glaucum*) finger millet (*Eleusinecoracana)*and small millets viz., foxtail millet, (*Setariaitalica*) little millet, (*Panicum sumatrense*) Kodo millet, (*Paspalumscrobiculatum)* proso millet (*Panicum miliaceum*) and barnyard millet (*Echinochloafrumentacea*). Millets are often referred to as coarse cereals, though due to high nutritional value they are now valued as nutri-cereals. Millets are particularly rich in minerals like iron, magnesium, phosphorus, and potassium. Finger millet is exclusively rich in calcium and its content is considered to be 10

times higher than that contained in rice or wheat. Millet proteins are reported to be the good sources of essential amino acids with relatively higher amounts of methionine except lysine and threonine, which are the limiting amino acids [5,6]. Thus, with reference to nutrient density, every millet is regarded as extraordinarily superior to rice and wheat and could be used as an alternative source of macro and micronutrients for combating malnutrition. Many Asian and African countries use millets to prepare various traditional foods and beverages viz; flat breads, dehydrated preserved wafers, porridge, fermented foods, weaning foods and snack foods [7].

Apart from minerals, millets are also known to possess antioxidant properties. Foxtail millet and proso millet were reported to contain 47 and 29 mg of polyphenolics and 3.34 and 2.22 mg of tocopherol per 100g respectively [8]. Phenolic extracts of whole grain millets like kodo, finger, foxtail, proso, pearl and little millet were shown to be the richest sources of phenolic compounds which exert antioxidant, metal chelating and reducing powers [9]. Hence, millets are being utilized as a source of nutraceutical components for nutritional enrichment of processed food products to augment their proposed health benefits. Consumption of finger millet based diet is known to regulate plasma glucose levels on account of its high fiber content. Further, the presence of antinutritional factors in finger millet based diets has been reported to reduce overall starch digestibility and thus result in lower absorbability [10]. Finger millet flour incorporated noodles were reported to have low glycemic effect [11]. Millets are said to possess cholesterol lowering property and thus have been linked to lowered risk of developing cardiovascular diseases [12].

Incorporation of millet in various low cost food formulations intended for adults and children could be used to alleviate malnutrition and other deficiency disorders and can serve as nutritionally dense value added products. The present investigation was carried out to formulate and evaluate the sensory quality and storage stability of millet based snack *poories* (which can be used with *chat* foods), with partial replacement of wheat flour to make it more nutritious. In addition, a consumer survey was also conducted to understand the frequency of consumption of *chat* foods.

METHODOLOGY

Materials

The ingredients used for preparation of products, namely, whole wheat flour (*Triticum aestivum*), sorghum (*Sorghum vulgare*), foxtail millet (*Setariaitalica)*, little millet (*Panicum miliare*), decorticated black gram flour (*Phaseolus mungo*), natural seafoam (a natural additive which is a combination of calcium chloride and other mineral salts and is used for imparting crisp texture) and common salt were procured from the local market. The millets were cleaned, processed into flour in milling machinery and were stored in air tight containers till further use. Refined sun flower oil (*Helianthus annuus*) was used for deep frying. Seafoam was ground into fine powder prior to adding it to the flour. All the chemicals and solvents used for the study were of analytical grade and were procured from E-Merck, Mumbai; SD Fine Chemicals, Mumbai; Qualigens Chemicals, Mumbai and Nice Chemical Laboratories, Kerala, India. Distilled water was used for all the analysis and all the estimations were carried out in duplicate.

Methods

The study was carried out in two phases which included a consumer survey and formulation of products incorporating millets.

Consumer survey

Phase-1 comprised of a consumer survey on a total of 250 subjects to know the consumption pattern of various *chat* items. The subjects were University students chosen randomly who reported the habit of snacking away from home. They were given a pre-tested interview schedule questionnaire. The information elicited from subjectsincluded frequency of consumption of *chat* foods, the preferred place of eating, dishes frequently chosen, factors influencing selection while eating, driving force for consumption of such snacks and health and hygiene aspects of *chats* eaten away from home. The data were compiled to throw light on the consumption pattern of snacks based on *chatpoories*.

Formulation of products

Phase-2 involved formulation and preparation of *chat poories* incorporated with millet flour, and analysis of *poories* for nutritional composition, sensory quality and storage stability.

Preparation of Poories

The control *poori* was prepared using whole wheat flour, (90g), decorticated black gram flour (10g), seafoam (2.0g) and common salt (2.0g). Initially all the ingredients were dry mixed. Thereafter a soft dough was prepared with water and allowed to rest for half an hour. It was divided into equal sized balls and was rolled into thin sheets. With the help of a cookie cutter the sheet was cut into small circular shapes of 3" diameter which were then deep fried (temperature, 175±2^{o}C) in sunflower oil till the color turned to golden brown.

For the millet incorporated products, wheat flour was replaced with millet flour, while the rest of the ingredients and process remained similar to the control product. The millets used were sorghum, foxtail and little millet. The proportion of millet incorporation was standardized in pilot trials. The levels selected for the incorporation of millet flour were 40 and 60% along with wheat flour as a base ingredient. In case of *poories* with 60% little millet flour, only 1% of sea foam was added in order to minimize the hardness.

Nutritional composition

All the prepared products were analyzed for nutritional composition. Moisture was estimated using oven drying method. Ash was determined by incineration of sample at 600^{o}C till all the organic constituents were burnt off and only ash remained. Fat was extracted using a solvent in Soxhlet distillation apparatus and determined gravimetrically. For estimation of protein content, Kjeldahl distillation was used for estimation of nitrogen in the sample which is subsequently converted to protein using a factor of 6.25. Dietary fiber was estimated by enzymatic-gravimetric method of Asp et al. [13] and calcium and iron were estimated in ash solution using standard techniques [14].

Sensory Analysis

The products were subjected to sensory analysis to determine the acceptability with reference to major sensory attributes such as appearance, color, texture, shape and taste by a total of 40 semi-trained panel members using a descriptive score card [15]. The panel members were presented with coded samples of the products along with a carrier material, i.e. potato stuffing. The maximum score for any given attribute was 10. The sensory analysis was conducted individually for all millet incorporated products with a control sample.

Storage Stability

As *chat poories*are stored for considerable period of time, it was of particular interest to analyze their storage stability using lipid peroxidation as criteria. Each set of products were stored in household refrigerator and at room temperature in polyethylene bags for a period of seven days. The products were analyzed for free fatty acid (FFA) and peroxide value (PV) by standard procedures on initial day and after storing for 7 days. FFA and PV were estimated in oil extracted from the sample as per the procedure defined in AOCS [16].

Statistical Analysis

All analytical data is presented as mean and standard deviation and tested for significance in comparison to control sample using Student's T test. The survey data were compiled as cumulative frequencies and tabulated. The sensory analysis data were subjected to Analysis of variance to determine the statistically significant differences among the products, if any.

RESULTS AND DISCUSSION

The results of the study are compiled in Tables 1-3 and Figures 1-2 and discussed below.

Consumer Survey

Table 1shows the responses of consumers for the survey on the consumption of chats, the questionnaire included questions on consumption pattern of *chat* based snacks and general awareness. *Chat* is a name given collectively for a set of dishes which use deep fried wheat flat breads with toppings of various beans, lentils, vegetables and spiced sauces. The response for the question on the consumption pattern of different *chat* items such as *masala poori* was found to be high (23%) followed by *dahipoori* (15%) and *panipoori* (14%). *Sevpoori* and *golgappa* consumption followed a similar trend. *Samosa masalapoori* consumption was also quite high (10%). Only 8% of the respondents reported to prefer eating *sukhapoori* and *bhelpuri*. The description of these items is provided along with the table for quick reference. The frequency of consumption showed that about 66.8% of the individuals consumed *chat* items 1-2 times in a week. Individuals consuming on occasional basis were around 15.2%, about 3-4 times a week – 12.0% and more than 5 times a week – 5.6%. This shows that occasional consumption of *chat* items was fairly common in the respondent's

group. Data on the replacement of main meal with a *chat* item showed that a considerably higher proportion (32.4%) of the individuals reported that their meals often get replaced with a *chat* item. On the other hand, 67.6% of them reported that they do not replace the main meals with a *chat* item.

With regard to the time of consumption of *chat* items, a majority (89.6%) informed that they consumed these during snack time. Consumption during lunch time (0.8%) and breakfast (1.6%) was relatively very small and during dinner time was about 8%. Information on the place of consumption indicated that individuals who prefer to consume chat items in a hotel were less (23.6%). Majority of the subjects showed preferential consumption in a street vended shop (64.8%) followed by in a restaurant (31.2%). Information regarding the preference for eating in one particular place was also collected which showed that about 39.6% of the respondents informed that they prefer to eat in one particular place, whereas majority (60.4%) of them said that they do not eat in one particular place.

Information related to the level of nutrition knowledge of consumers revealed that a very small percentage of respondents thought that they were nutritious (14%) or healthy (13%), while a higher percentage thought they were non-nutritious (19%) and unhealthy (20%). Information on the hygienic aspects of various chat items revealed that 18% of the respondents considered the place of eating as clean most of the time and around 16% thought that it was not clean. The episodes of illness experienced by consumers after the consumption of chat item implied that majority (72%) of the respondents did not suffer from any kind of illness, while the rest of the subjects reported to have suffered from some illness.

Table1. *Pattern of Chat consumption: Results of Consumer survey*

No.	Question	Option	Percent	Option	Percent
1.	Consumption pattern	*Panipoori*	14.0	*Samosa masala poori*	10.0
		Masala poori	23.0	*Bhelpuri*	8.0
		Sevpoori	11.0	*SukhaPoori*	8.0
		Dahipoori	15.0	*Golgappa*	11.0
2.	Frequency of consumption per week	1-2 times	66.8	5 times or more	5.6
		3-4 times	12.0	Occasionally	15.2
3.	Replacement of meal with Chat	Yes	32.4	No	67.6
4.	Time of consumption	Breakfast	1.6	Snack	89.6
		Lunch	0.8	Dinner	8.0
5.	Preference for eating place	Yes	39.6	No	60.4
6.	Place of consumption	Street vendor	64.8	Restaurant	31.2
		Hotel	23.6	Any other	17.2
7.	Opinion on health and hygiene of such foods	Nutritious	14	Unhealthy	20
		Non-nutritious	19	Clean	18
		Healthy	13	Not clean	16
8.	Episodes of illness related to chat consumption	Yes	28.4	No	72.0
9.	Price as criteria of purchase	Yes	44.0	No	56.0
10.	Driving forces for consumption	Television	17.0	Family members	16.0
		Friends	58.0	Others	9.0
11.	Influence of media	Most of the times	10.4	Not at all	28.4
		Sometimes	40.4	Rarely	20.4

Footnote. *Description of chat dishes:*

Panipoori	Fried small *poories* stuffed with boiled potatoes and eaten with finely cut tomatoes, onions and spiced water.
Masala poori	Fried small *poories* eaten with finely cut tomatoes, onions and spiced chutneys.
Sevpoori	These are *poories* topped with diced potatoes, onions. The addition of three types of chutneys: tamarind, chili and garlic along with topped '*sev'* (fried lentil shreds) imparts rich taste.
Dahipoori	The round, puffy *poori*shell is broken on top and partially stuffed with mashed potatoes or chickpeas. Sweet tamarind chutney and spicy green chutney are then poured into the shell, on top of the stuffing. Finally, sweetened beaten yoghurt is poured over it. This is garnished with crushed '*sev'*, fried green gram dhal, pomegranate and finely chopped coriander leaves.
Samosa	Fried small *poories* are served with *samosas* (a deep fried wheat based product stuffed with

masala poori	mashed potato, onion, green peas and spice mixes) topped with finely cut tomatoes, onions and spiced chutneys.
Bhelpuri	It is basically a savoury snack made of puffed rice, vegetables and a tangy tamarind sauce. It can also be served with sweet sauce made of jaggery and dates paste.
SukhaPoori	It is often served as a complimentary snack. It is a dry version of *sevpoori* filled with spiced potato stuffing and topped with generous amount of fine '*sev*'.
Golgappa	It differs from *panipoori*with respect to content and taste. It employs a mixture of boiled gram and mashed potatoes as the filling and is tangy rather than sweetish while the water which is served along with the *poories*is sour and spicy.

The influence of price on *chat* item consumption showed that majority (56%) of the respondents did not consider price as a major criteria, while the rest considered the price while ordering for any *chat* item. The major driving force for consuming various *chat* items was found to be friends, (58%) followed by television advertisements and family members. The influence of media on consumption trends of chat items indicated that a comparatively higher proportion of the respondents (40%) reported that media influenced them very rarely, 28% were not influenced, whereas 11% were influenced most of the times.

The survey results in general indicated a mixed opinion on the preferences of consumer consuming chats. A survey done in Mandya city by Poornima et al., [17] on the consumption of fast foods and other foods showed that it was more common in young adults than in people of older age groups. There was no statistically significant difference among males and females for frequent consumption of fried foods, *chat* based snacks, bakery and convenience foods.

Nutritional Composition of Formulated Products

Chatpoories were prepared utilizing different types of millets and the nutritional composition of formulated products is given in Table 2. The moisture content of *poories* varied between 1.12-2.49% with least in *poories* with 40% sorghum flour and highest in *poories* with 60% foxtail millet. Fat estimation indicated that the control *poories* had the highest fat content of 36.87%, followed by 40% sorghum (27.39%), 40% little millet (27.25%), 60% foxtail millet (26.66%) and 60% sorghum *poories* with 25.32%. Deep fried products are known for high fat content, hence any steps taken to reduce the oil content is welcome to lower the fat consumption. In the present study, incorporation of millet flour brought down the oil absorption in the products, which is a desirable step to lower the oil consumption through consumption of these snack foods. On an average millet incorporated *poories* absorbed 29% less fat which was significantly lower than control product.

Table 2 . *Nutritional Analysis of ChatPoories: as such basis (g/100g)*

Products	Moisture(g)	Fat(g)	Protein(g)	Ash(g)	Iron(mg)	Calcium(mg)	Dietary Fiber (g)
Wheat Poories (Control)	1.24 ± 0.21	36.87 ± 0.43	5.28 ± 0.00	2.03 ± 0.00	6.23 ±0.00	182 ± 0.20	7.6 ± 0.21
Sorghum, 40%	1.12 ± 0.39	27.39± 0.62**	5.68± 0.00*	2.75 ±0.01	5.31 ±0.08***	263 ± 0.21***	8.7 ± 0.14**
Sorghum, 60%	1.97± 0.17	25.32±1.68***	5.78± 0.00*	2.45± 0.04	5.50 ± 0.07**	298± 0.72***	11.5± 0.10***
Foxtail Millet, 40%	1.32 ± 0.22	24.21± 0.71***	6.56± 0.00**	2.82 ±0.01	6.60± 0.15*	164± 0.14*	6.5± 0.18**
Foxtail Millet, 60%	2.49 ± 0.53	26.66±0.87***	7.04± 0.00**	2.33 ±0.01	5.44 ±0.08***	308 ± 0.39***	7.4 ± 0.26^{ns}
Little millet, 40%	1.73 ± 0.33	27.25± 0.22***	5.75± 0.00**	2.36 ±0.01	5.82 ± 0.16*	435± 0. 42***	7.9* ± 0.16
Little millet, 60%	1.83 ± 0.06	26.14 ±0.32***	6.00± 0.00*	1.89 ±0.03	6.76 ± 0.00**	248± 0.44***	10.7 ± 0.14***

*Significantly different from control sample on application of T test. ***: P≤ 0.001, **: P≤ 0.01, *: P≤ 0.05, ns: not significant, P> 0.05.*

Use of ingredients such as soy proteins, additives and gums has been tried by scientists to reduce fat uptake in fried products [18-20]. Our earlier studies have demonstrated that soy flour has positive effect in fat reduction in various fried products [21-23]. During deep fat frying water in the crust evaporates and move out of the food. In order to continue the flow of vapor, sufficient water should be able to migrate from the core of the food to the crust [24]. Porosity and fat uptake in foods are inversely related to moisture content at various time stages during deep frying [25,26]. Surface characteristics of fried products and particularly the geometrical irregularities or roughness are highly important in oil absorption kinetics. In the present study, among the prepared products, little millet flour *poori* had higher surface roughness in both raw and fried state, however, the oil uptake was shown to be comparatively

lesser in all millet incorporated products than the control.

The protein content of both 40 and 60% foxtail millet *poori* was found to be the highest compared to other variations (6.56 and 7.04g/100g). Control *poories* had a protein content of 5.28g/100g. Sorghum and little millet *poori* also had appreciably higher protein content. The differences were significant. The amount of ash represents the amount of mineral elements present in a particular food product. The analysis revealed that 40% foxtail millet *poori* had highest ash content (2.82%) and lowest amount of ash content was obtained for *poories* with 60% little millet rice flour. For control *poories* the ash content was in between (2.03%).

Iron is one of the important mineral elements. In the present study, the estimated iron content of wheat, sorghum and foxtail millet products were found to be satisfactory. Among the prepared products, control *poories* had 6.23mg iron/100g of the product. Among the variations 60% little millet and 40% foxtail millet *poories* had comparatively higher amounts of iron (6.76mg and 6.6mg iron/100g respectively). The iron content of remaining variations was found to be more than 5.0 mg/100g. Millets are poor sources of calcium. The reported values for calcium content of foxtail millet, sorghum, and little millet as per nutritional composition of Indian foods is 31, 25 and 17mg/100g respectively, which is negligible[27]. The calcium content of the prepared products was found to be quite high which might be due to the addition of sea foam (an additive) which is a deposition of the mineral salts, specifically calcium chloride which could have contributed to the higher values. The estimated calcium content of the *poories* with 40% little millet rice was indicated to be the highest (435mg/100g). Millets are considered to be the very good sources of fiber and are implicated in the prevention of various GI disorders. The prevalence of obesity and diabetes have been reported to have increased globally. Thus, foods that are known to contain complex carbohydrates and higher amounts of dietary fiber along with health promoting components like phytochemicals are gaining more importance as a means of combating the increasing disease burden [28]. The estimation of dietary fiber revealed that sorghum and little millet *poories* had significantly higher amount of dietary fiber. In recent years there has been an increase in the utilization of millets in food formulation due to the fact that they contain appreciably higher amounts of nutrients and nutraceutical components that needs to be consumed in greater amounts and is regarded as the need of the hour to prevent multiple micronutrient deficiency disorders [29].

Storage Stability

Storage stability of *chat poories* was determined by storing the prepared products at room temperature and under refrigeration (low) for 7 days and determining the extent of lipid peroxidation in stored products. The results are given in Figure 1 and 2.The parameters which were chosen to assess the shelf stability was FFA content as percent oleic acid and peroxide value as meq/kg of oil of prepared product which was analyzed at different time intervals i.e. on the day of preparation and after 7 days of storage. The control product had a very low FFA of 0.19% on 0^{th} day and after 7 days at room temperature showed a slight increase in FFA (0.21%). This further increased as the level of incorporation of millet flour was increased. The range of FFA in millet incorporated products were 0.30-0.47% on initial day which remained similar on low temperature storage and showed a slight increase at room temperature storage.

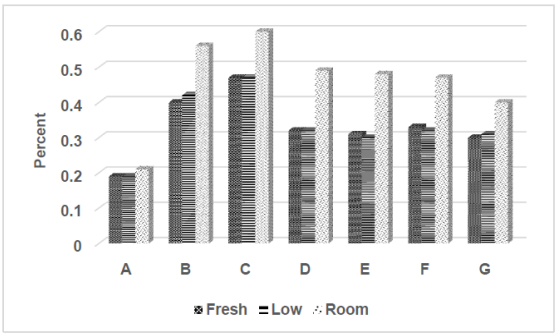

Figure1. *Effect of Storage on Free Fatty Acid of Poories (% Oleic acid /100g)*

[A: Wheat (Control), B: 40% Sorghum, C: 60% Sorghum, D: 40% Foxtail millet, E: 60% Foxtail millet, F: 40% Little millet, G: 60% Little millet.]

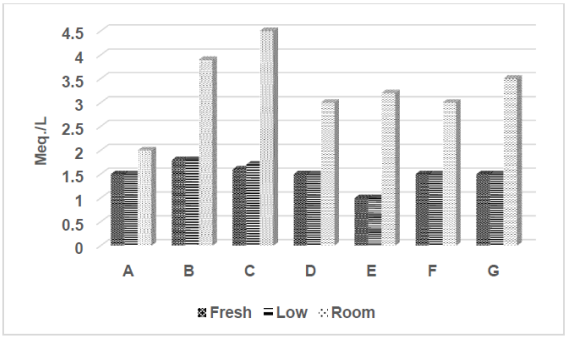

Figure2. *Effect of Storage on Peroxide Value of Poories*

[A: Wheat (Control), B: 40% Sorghum, C: 60% Sorghum, D: 40% Foxtail millet, E: 60% Foxtail millet, F: 40% Little millet, G: 60% Little millet.]

Overall results indicated that there was a mild increase in the FFA content of all the stored products with increase in the duration of storage. The extent of increase was much lesser in refrigerated storage. The increase in FFA content during storage of product could be due to an increase in the rate of triacylglycerol hydrolysis when the moisture content of the product and the air inside the container reacts with absorbed oil of the product. It has been reported that during prolonged heating and in the presence of food moisture, hydrolysis of oil takes place and ester linkages are broken to yield FFA ultimately resulting in the increase in their concentration [30]. Similar results were reported by Sebastian et al [31] who studied the storage stability of fried snack products incorporated with finger millet flour. Products stored at low temperature had lower level of lipid peroxidation than the ones stored at room temperature. However, overall increase in FFA content was not very high ranging from 0.165 – 0.213%.

The peroxide value (PV) of all the products stored at room temperature (RT) and low temperature (LT) is presented in Table 3. PV is a measure of the amount of peroxides formed in fats and oils through autoxidation and oxidation processes. Indirectly it measures the initial oxidation of the product. For the *chat poories* prepared by incorporating different levels of selected millet flours for 0 day, the PV ranged between 1.0-1.8 meq/kg of the product. Among the variation products, *poories* with 40% and 60% sorghum exhibited a slightly higher PVs (1.8 and 1.7 meq/kg). *Poories* with 60% foxtail millet had comparatively lower values (1.0meq/kg). For products with 40% foxtail millet and 40% and 60% little millet flour *poories*, the PVs were similar (1.5meq/kg). Among the products stored at RT, control *poories* had lower values, whereas slightly higher PVs were encountered for sorghum incorporated *poories*. This increase in PV can be considered negligible and much lesser in comparison to other studies [22].In fried products, ingredient composition, packaging material and frying medium are thought to influence the rate of peroxidation and can also change the organoleptic quality [32].

Table 3. *Mean sensory scores of formulated products*

Sensory parameters	Whole wheat *poories*	With 40% Millet	With 60% Millet	ANOVA	
				F- value	P- value
***Poories* with Sorghum**					
Appearance	8.13 ± 1.00	8.00 ± 0.69	7.56 ± 0.85	3.42	0.0368*
Colour	8.20 ± 1.00	7.90 ± 0.66	7.77 ± 0.73	1.78	0.173 ^{ns}
Shape	8.37 ± 0.93	7.93 ± 1.12	7.66 ± 1.34	2.687	0.073 ^{ns}
Texture	8.23 ± 1.43	8.24 ± 0.63	7.48 ± 0.82	5.185	0.007**
Taste	8.20 ± 1.10	8.63 ± 0.72	7.83 ± 0.91	5.76	0.0044**
***Poories* with Foxtail millet**					
Appearance	7.63 ± 1.42	8.06 ± 0.69	7.13 ± 0.97	5.67	0.0048**
Colour	7.70 ± 1.20	8.06 ± 0.64	7.83 ± 0.59	1.442	0.241 ^{ns}
Shape	7.77 ± 1.48	7.93 ± 0.94	7.83 ± 1.46	0.121	0.885 ^{ns}
Texture	8.23 ± 1.22	8.10 ± 0.80	7.83 ± 0.98	1.011	0.368 ^{ns}
Taste	8.30 ± 1.20	8.23 ± 0.73	8.13 ± 0.97	0.151	0.859 ^{ns}
***Poories* with Little millet**					
Appearance	8.16 ± 1.05	7.93 ± 0.82	6.80 ± 1.15	15.37	0.04*
Colour	8.30 ± 1.00	8.16 ± 0.75	7.93 ± 0.94	1.033	0.360 ^{ns}
Shape	7.93 ± 1.34	7.70 ± 0.75	7.73 ± 1.20	0.377	0.686 ^{ns}
Texture	8.00 ± 1.02	7.90 ± 0.92	7.73 ± 1.01	0.560	0.573 ^{ns}
Taste	8.20± 1.20	8.13 ± 0.73	8.43 ± 0.73	0.820	0.443 ^{ns}

*Significant differences among samples on application of ANOVA, **: $P \leq 0.01$, *: $P \leq 0.05$, ns: not significant, $P > 0.05$.*

Sensory Analysis

The results of sensory analysis of products formulated with three types of millets are compiled in Table 4. The important observations are as follows -for sorghum incorporated *poories*, the sensory scores for lower level of incorporation (40%) were closer to control product, though higher level resulted in lower scores in comparison to control with differences being significant for appearance, texture and taste. For colour and shape, products were rated as similar to control with no significant

differences. For *poories* with foxtail millet, only the attribute of appearance was rated as significantly lower for 60% incorporation, while there were no differences for all other attributes. Similar observations were seen for *poories* with little millet. These results indicate that overall chat *poories* made with millet flour were acceptable. The slightly lower scores for appearance could have been due to poor puffing of *poories* incorporated with millet. Shape is one of the important parameter considered. An ideal *poori* should have optimal level of puffing and depending on the degree of puffing the end use can be determined. In case of *poories* made with wheat flour the product puffs to a greater extent. Whereas in the present study it was observed that the *poories* with 60% millet flour had minimal level of puffing and it had a flat appearance. Sebastian et al [31] conducted a study on the quality attributes of a fried rice based snack incorporated with different levels of finger millet flour. Lower levels of addition resulted in an acceptable product, and higher levels of addition received lower scores for the product. This indicates that higher level of incorporation of millet affected the product adversely, specifically, the attribute of appearance and colour were affected with finger millet.

CONCLUSION

The incorporation of millet flour to chat *poories* had a greater impact on the quality attributes. The incorporation of millet flours at different levels resulted in varied responses given for each variation. Due to lower level of gluten the *poories* did not have greater amount of expansion or puffiness. They all had flatter appearance, yet were tastier with optimal nutritional components. The millets that were investigated were found to have appreciable amount of protein and dietary fiber. Hence, they can be used in developing value added products. Millets due to its high fiber content is proposed to prevent various forms of cancer, cardiovascular diseases, diabetes and obesity. Hence, it could be said that there is a need to create awareness among the general population about the beneficial effects of using millets as they are still considered to be underutilized crops in certain parts of the country. Millets due to its wholesomeness can serve to improve the overall nutritional status of an individual.

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