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*Original Article*

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# The Impact of Storage Period on Chemical Composition of Value Added Supplementary Foods

**Neer Kamal Brar*, Balwinder Sadana**, Poonam Bakhetia*****

**Abstract**

Supplementary foods namely *mathi, shakarpara, saviyan, bhujia mix* and biscuits were developed using refined wheat flour (RWF), defatted soy flour (DSF), colocasia leaf powder (CLP) and amla powder (AP). *Mathi* and *shakarpara* supplemented with 7.5% CLP and 5% AP, whereas *saviyan* and *bhujia mix*, supplementation level of CLP and AP was 2.5 % each. In biscuits both powders were added at 5% level. RWF and defatted soy flour were used in the ratio of 4:1. Formulated supplementary foods were nutritionally evaluated in terms of peroxide value, free fatty acid and sugars at an interval of 0, 30, 45 and 60 days. The peroxide value at 0 days ranged from 1.5 (*bhujia mix*) to 3.2 mEq / kg (biscuits) in control, whereas minimum free fatty acid content was observed in *saviyan* (0.09%) and maximum in biscuits as 0.13% in control group. With increase in storage period total and reducing sugars showed non significant increase, whereas non reducing sugars, free fatty acids and peroxide value showed significant increase ($p<0.05$). Hence, developed value added supplementary foods can be easily prepared and stored at domestic level without altering their composition.

**Keywords:** Supplementary Foods; Value Addition; Peroxide Value; Free Fatty Acid Value and Sugar Content.

## Introduction

Iron deficiency anaemia (IDA), along with vitamin A deficiency (VAD) continue to pose a significant challenge to public health to all over India. Anaemia affects more than a billion people of entire world (UNDP, 1998). The prevalence of anaemia was reported to be about 69% in preschool children, 70% in adolescent girls, 74% in pregnant women and 75% in lactating women (NNMB, 2003). Main cause of iron deficiency anaemia is inadequate intake of iron as well as its poor bioavailability from vegetarian diet. A positive correlation between inadequate intake of vitamin A and higher prevalence of anaemia has been demonstrated. Pre-school children are the most vulnerable group of the total population of India (Bhat and Kaur, 2004). In India 52,000 children go blind every year on account of vitamin A deficiency (Pal and Sagar, 2007). Subclinical deficiency of vitamin A is an important cause of childhood mortality and morbidity among children (Laren and Frig, 2001). The three major approaches to combat IDA and VAD are supplementation, food fortification and dietary diversification (Reddy *et al*, 1993). The most rational, sustainable and long term solution therefore lies in increasing the productivity and availability of vitamin A / ß carotene and iron rich foods which ultimately are consumed by vulnerable group of population (Subapriya and Chandrashekhar, 2006, Tang *et al*, 2005). The global public health problems of iron deficiency anaemia and vitamin A can be taken care of by value addition of iron and vitamin C in local food preparation of cereals and pulses available at every door step of Indian home.

## Materials and Methods

For the preparation of *mathi, shakarpara, saviyan,* biscuits and *bhujia mix*, refined wheat flour, defatted soy flour, rice flakes, hydrogenated fat, refined oil, sugar, salt and jaggery of good quality were purchased from the local market while colocasia leaves (*colocasia esculenta*) were purchased from local vegetable market. *Amla* (*Emblica officinalis*) was procured from vegetable department of Punjab

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**Table 1:** Methodology Used For Preparation of Supplementary Foods.

| Product | Ingredients | Amount (g) | Methods |
|---|---|---|---|
| Mathi | RWF<br>Hydrogenated fat<br>Salt<br>Refined Oil | 100<br>20<br>5<br>For frying | Add salt in refined wheat flour and sieve it. Then add hydrogenated fat in flour and knead it to stiff dough. Shape the dough in small balls. Roll the balls into shape of *mathi.* Fry *mathies* in hot oil till golden brown. |
| Shakarpara | RWF<br>Hydrogenated fat<br>Jaggery<br>Refined Oil | 100<br>20<br>150<br>For frying | Add hydrogenated fat in flour then knead into firm dough. Shape the dough in small balls. Roll these balls and cut into diamond shape pieces. Fry pieces in hot oil till golden brown. Prepare jaggery syrup and dip pieces into it. |
| Saviyan | RWF<br>Hydrogenated fat<br>Salt<br>Refined Oil | 100<br>20<br>5<br>For frying | Add salt in refined wheat flour and sieve it. Then add hydrogenated fat in flour, and then knead stiff dough. Pass the dough through hand operated machine. Fry them in *kadahi* into hot oil till golden brown. |
| Biscuits | RWF<br>Powdered sugar<br>Baking powder<br>Butter<br>Eggs | 100<br>20<br>¾ tsp<br>100<br>2 | Sift the flour and baking powder together two or three times. Cream fat and sifted sugar together till the become light and fluffy. Beat the egg together with vanilla essence to make foam. Add sugar-fat cream and egg foam into flour lightly with fork till smooth dough is formed. Divide the dough into small pieces and make the desired shape of biscuits. Place them on greased baking sheet and bake at 325° F for 15 to 20 minutes. |
| Bhujia mix | Rice flakes<br>Powdered sugar<br>Salt<br>Peanut<br>Refined Oil | 100<br>20<br>5<br>15<br>For frying | Put some oil in *kadahi* and add rice flakes and peanuts for roasting. Then add powdered sugar and salt in mixture. Roast for 5-8 minutes. |

S1= RWF
S2=RWF+DSF (4:1)
S3=S2+7.5/5/2.5% (CLP)
S4=S3+5/2.5% AP

**Table 2:** Effect of Storage Period on Per-Oxide Value (Meq/Kg) of Supplementary Foods

| Time period | Mathi | Shakarpara | Saviyan | Biscuits | Bhujia Mix |
|---|---|---|---|---|---|
| 0 day | | | | | |
| $S_1$ | 2.7±0.05 | 2.2±0.05 | 2.2±0.14 | 3.2±0.07 | 1.5±0.25 |
| $S_2$ | 3.0±0.07 | 2.0±0.12 | 3.0±0.11 | 3.0±0.15 | 1.2±0.15 |
| $S_3$ | 3.1±0.12 | 2.8±0.07 | 2.8±0.37 | 2.8±0.05 | 1.6±0.07 |
| $S_4$ | 2.8±0.25 | 2.3±0.50 | 2.5±0.54 | 3.4±0.50 | 1.3±0.31 |
| 30 days | | | | | |
| $S_1$ | 3.2±0.50 | 3.5±0.23 | 3.5±0.25 | 3.8±0.12 | 2.0±0.32 |
| $S_2$ | 4.8±0.50 | 2.9±0.17 | 3.8±0.10 | 3.4±0.17 | 2.2±0.43 |
| $S_3$ | 4.0±0.34 | 3.2±0.32 | 3.2±0.22 | 3.4±0.25 | 1.8±0.05 |
| $S_4$ | 3.5±0.12 | 3.7±0.25 | 3.0±0.05 | 3.9±0.10 | 1.9±0.07 |
| 45 days | | | | | |
| $S_1$ | 3.8±0.25 | 3.8±0.43 | 4.3±0.13 | 4.0±0.07 | 2.2±0.50 |
| $S_2$ | 5.0±0.05 | 3.3±0.23 | 4.4±0.25 | 3.9±0.03 | 2.5±0.13 |
| $S_3$ | 4.6±0.20 | 3.9±0.50 | 3.8±0.07 | 3.7±0.25 | 2.4±0.25 |
| $S_4$ | 4.3±0.05 | 4.2±0.05 | 3.8±0.05 | 4.3±0.17 | 2.2±0.22 |
| 60 days | | | | | |
| $S_1$ | 4.5±0.07 | 4.3±0.05 | 4.9±0.25 | 4.3±0.06 | 2.8±0.05 |
| $S_2$ | 5.5±0.34 | 4.1±0.07 | 5.1±0.03 | 4.5±0.05 | 2.6±0.15 |
| $S_3$ | 5.1±0.15 | 4.5±0.15 | 4.5±0.15 | 4.0±0.15 | 2.7±0.23 |
| $S_4$ | 5.2±0.19 | 4.8±0.20 | 4.4±0.25 | 4.6±0.25 | 2.4±0.25 |
| F-Ratio (columns, storage period) | 0.62 | 18.46 | 10.51 | 6.34 | 7.64 |
| CD (5%) | - | 0.179 | 0.425 | 0.354 | 0.335 |
| F-Ratio (Rows, Treatments) | 18.42 | 90.45 | 48.01 | 67 | 71.3 |
| CD (5%) | 0.362 | 0.179 | 0.425 | 0.354 | 0.335 |

Agricultural University, Ludhiana. For processing of the leaves they were thoroughly washed, cleaned, dried in hot air oven at 60±2$^0$C. Dried leaves were ground and sieved to obtain a fine powder and were sealed in air tight zip pouches, whereas *amla* fruits were washed, blanched for 5-7 minutes, deseeded, dried at 60±2$^0$C and grounded to fine powder and stored in air tight container. Developed products were based on RWF as single and with combination of DSF, CLP and AP at different levels of supplementation. The ingredients, amounts and method of preparation used in developing products are given in Table 1.

**Table 3:** Effect of storage period on free fatty acid (%) content of supplementary foods

| Time period | Mathi | Shakarpara | Saviyan | Biscuits | Bhujia Mix |
|---|---|---|---|---|---|
| 0 day | | | | | |
| $S_1$ | 0.12±0.50 | 0.11±0.15 | 0.09±0.45 | 0.13±0.05 | 0.12±0.05 |
| $S_2$ | 0.13±0.07 | 0.18±0.25 | 0.11±0.34 | 0.10±0.07 | 0.14±0.07 |
| $S_3$ | 0.10±0.25 | 0.15±0.05 | 0.12±0.23 | 0.12±0.15 | 0.14±0.15 |
| $S_4$ | 0.11±0.25 | 0.12±0.50 | 0.12±0.23 | 0.10±0.25 | 0.11±0.25 |
| 30 days | | | | | |
| $S_1$ | 0.18±0.05 | 0.18±0.23 | 0.14±0.05 | 0.20±0.50 | 0.22±0.50 |
| $S_2$ | 0.15±0.13 | 0.20±0.12 | 0.15±0.13 | 0.25±0.05 | 0.22±0.25 |
| $S_3$ | 0.14±0.35 | 0.17±0.34 | 0.13±0.23 | 0.18±0.12 | 0.17±0.15 |
| $S_4$ | 0.17±0.05 | 0.20±0.05 | 0.15±0.25 | 0.22±0.32 | 0.20±0.17 |
| 45 days | | | | | |
| $S_1$ | 0.20±0.07 | 0.25±0.34 | 0.17±0.42 | 0.34±0.23 | 0.28±0.34 |
| $S_2$ | 0.17±0.50 | 0.28±0.23 | 0.20±0.50 | 0.38±0.20 | 0.23±0.43 |
| $S_3$ | 0.16±0.17 | 0.24±0.12 | 0.18±0.55 | 0.23±0.32 | 0.19±0.05 |
| $S_4$ | 0.19±0.43 | 0.22±0.25 | 0.20±0.25 | 0.37±0.12 | 0.16±0.50 |
| 60 days | | | | | |
| $S_1$ | 0.31±0.14 | 0.32±0.34 | 0.28±0.15 | 0.40±0.34 | 0.30±0.34 |
| $S_2$ | 0.17±0.20 | 0.36±0.23 | 0.26±0.05 | 0.45±0.12 | 0.25±0.12 |
| $S_3$ | 0.17±0.07 | 0.28±0.23 | 0.20±0.15 | 0.34±0.20 | 0.27±0.15 |
| $S_4$ | 0.20±0.50 | 0.30±0.23 | 0.23±0.23 | 0.41±0.25 | 0.22±0.34 |
| F-Ratio (columns, storage period) | 3.3 | 2.2 | 3.1 | 0.82 | 5.1 |
| CD (5%) | - | - | - | - | 0.031 |
| F-Ratio (Rows, Treatments) | 16.45 | 36.13 | 7.72 | 29.0 | 61.7 |
| CD (5%) | 0.043 | 0.070 | 0.047 | 0.034 | 0.031 |

**Table 4:** Effect of Storage on Total Sugars (%) of Supplementary Foods.

| Time period | Mathi | Shakarpara | Saviyan | Biscuits | Bhujia Mix |
|---|---|---|---|---|---|
| 0 day | | | | | |
| $S_1$ | 29.8±0.12 | 39.8±0.12 | 25.6±0.14 | 27.8±0.13 | 39.0±0.11 |
| $S_2$ | 32.4±0.11 | 30.4±0.16 | 28.4±0.13 | 29.1±0.17 | 30.9±0.11 |
| $S_3$ | 30.0±0.15 | 32.1±0.05 | 31.2±0.17 | 31.6±0.12 | 31.4±0.15 |
| $S_4$ | 35.2±0.10 | 37.2±0.14 | 32.5±0.15 | 34.0±0.11 | 37.3±0.13 |
| 30 days | | | | | |
| $S_1$ | 30.0±0.13 | 40.1±0.12 | 25.7±0.13 | 28.0±0.11 | 39.4±0.13 |
| $S_2$ | 32.4±0.09 | 31.2±0.14 | 29.0±0.11 | 29.7±0.14 | 31.0±0.10 |
| $S_3$ | 30.5±0.13 | 32.4±0.11 | 30.6±0.15 | 31.8±0.15 | 31.8±0.17 |
| $S_4$ | 35.2±0.15 | 37.5±0.12 | 32.6±0.14 | 34.5±0.13 | 37.6±0.11 |
| 45 days | | | | | |
| $S_1$ | 30.1±0.13 | 40.4±0.12 | 25.3±0.11 | 28.4±0.13 | 39.8±0.15 |
| $S_2$ | 32.6±0.11 | 31.5±0.13 | 29.5±0.15 | 30.0±0.14 | 31.4±0.11 |
| $S_3$ | 31.0±0.14 | 32.4±0.11 | 31.0±0.11 | 32.0±0.12 | 32.1±0.14 |
| $S_4$ | 35.2±0.12 | 37.8±0.10 | 32.8±0.11 | 34.8±0.09 | 37.3±0.12 |
| 60 days | | | | | |
| $S_1$ | 30.1±0.13 | 40.5±0.14 | 26.0±0.12 | 28.7±0.07 | 39.9±0.12 |
| $S_2$ | 32.7±0.10 | 31.6±0.12 | 29.7±0.15 | 30.3±0.14 | 31.9±0.14 |
| $S_3$ | 31.1±0.14 | 32.6±0.11 | 31.4±0.17 | 32.5±0.17 | 32.7±0.11 |
| $S_4$ | 35.5±0.09 | 38.0±0.13 | 33.0±0.11 | 35.0±0.11 | 37.5±0.13 |
| F-Ratio (columns, storage period) | 1128 | 2840 | 538 | 140 | 2664 |
| CD (5%) | 0.386 | 0.166 | 0.327 | 0.719 | 0.268 |
| F-Ratio (Rows, Treatments) | 8.35 | 69.4 | 5.0 | 1.5 | 19.0 |
| CD (5%) | 0.386 | 0.166 | 0.327 | - | 0.265 |

**Table 5:** Effect of Storage on Reducing Sugars (%) of Supplementary Foods.

| Time period | Mathi | Shakarpara | Saviyan | Biscuits | Bhujia Mix |
|---|---|---|---|---|---|
| 0 day | | | | | |
| $S_1$ | 28.5±0.10 | 39.5±0.12 | 25.6±0.14 | 27.2±0.17 | 38.7±0.09 |
| $S_2$ | 32.0±0.09 | 30.8±0.09 | 29.7±0.13 | 28.4±0.14 | 30.4±0.15 |
| $S_3$ | 28.5±0.15 | 31.8±0.11 | 31.2±0.17 | 31.1±0.15 | 31.0±0.15 |
| $S_4$ | 34.8±0.12 | 36.7±0.14 | 31.8±0.15 | 33.7±0.11 | 36.7±0.13 |
| 30 days | | | | | |
| $S_1$ | 28.4±0.12 | 39.4±0.12 | 25.5±0.13 | 26.7±0.11 | 38.5±0.17 |
| $S_2$ | 31.8±0.10 | 30.7±0.11 | 29.6±0.11 | 28.2±0.12 | 30.0±0.11 |
| $S_3$ | 28.3±0.14 | 31.5±0.16 | 30.8±0.15 | 30.8±0.16 | 30.8±0.12 |
| $S_4$ | 34.6±0.11 | 36.6±0.10 | 31.6±0.14 | 33.5±0.13 | 36.4±0.,13 |
| 45 days | | | | | |
| $S_1$ | 28.4±0.14 | 39.3±0.14 | 25.3±0.11 | 26.5±0.13 | 38.1±0.11 |
| $S_2$ | 31.5±0.15 | 30.7±0.13 | 29.4±0.15 | 28.0±0.11 | 29.8±0.14 |
| $S_3$ | 28.1±0.16 | 31.8±0.15 | 30.4±0.11 | 30.4±0.15 | 30.5±0.17 |
| $S_4$ | 34.5±0.11 | 36.4±0.12 | 31.6±0.11 | 33.3±0.12 | 36.2±0.12 |
| 60 days | | | | | |
| $S_1$ | 28.1±0.08 | 39.0±0.13 | 25.2±0.12 | 26.1±0.11 | 37.80±0.15 |
| $S_2$ | 31.4±0.11 | 30.5±0.12 | 29.1±0.15 | 27.7±0.15 | 29.71±0.12 |
| $S_3$ | 28.0±0.13 | 31.4±0.11 | 30.4±0.17 | 30.0±0.17 | 30.16±0.11 |
| $S_4$ | 34.2±0.13 | 36.2±0.12 | 31.1±0.11 | 33.1±0.14 | 36.0±0.12 |
| F-Ratio (columns, storage period) | 7909 | 1553 | 4048 | 134 | 27 |
| CD (5%) | 0.15 | 0.23 | 0.15 | 0.75 | 2.4 |
| F-Ratio (Rows, Treatments) | 61.4 | 25.2 | 21.04 | 1.4 | 1.41 |
| CD (5%) | 0.15 | 0.23 | 0.15 | - | - |

**Table 6:** Effect of Storage on Non-Reducing Sugars (%) of Supplementary Foods

| Time period | Mathi | Shakarpara | Saviyan | Biscuits | Bhujia Mix |
|---|---|---|---|---|---|
| 0 day | | | | | |
| $S_1$ | 1.32±0.12 | 0.81±0.12 | 0.48±0.07 | 0.61±0.11 | 0.32±0.17 |
| $S_2$ | 0.39±0.11 | 0.58±0.11 | 0.41±0.11 | 0.71±0.13 | 0.48±0.15 |
| $S_3$ | 1.5±0.15 | 0.24±0.12 | 0.48±0.12 | 0.54±0.14 | 0.42±0.14 |
| $S_4$ | 0.33±0.12 | 0.44±0.13 | 0.54±0.15 | 0.24±0.17 | 0.64±0.17 |
| 30 days | | | | | |
| $S_1$ | 1.62±0.13 | 0.65±0.14 | 0.84±0.16 | 1.33±0.16 | 0.94±0.16 |
| $S_2$ | 0.58±0.11 | 0.45±0.11 | 1.21±0.14 | 1.50±0.11 | 1.04±0.11 |
| $S_3$ | 2.13±0.14 | 0.9±0.13 | 0.58±0.11 | 1.0±0.13 | 1.0±0.12 |
| $S_4$ | 0.65±0.12 | 0.74±0.15 | 0.82±0.13 | 1.37±0.17 | 1.41±0.14 |
| 45 days | | | | | |
| $S_1$ | 1.7±0.15 | 1.09±0.13 | 1.03±0.12 | 1.90±0.13 | 1.66±0.11 |
| $S_2$ | 1.1±0.16 | 0.87±0.13 | 1.91±0.17 | 2.0±0.12 | 1.62±0.14 |
| $S_3$ | 2.89±0.11 | 0.62±0.15 | 1.37±0.12 | 1.62±0.17 | 1.61±0.15 |
| $S_4$ | 0.79±0.14 | 0.79±0.13 | 1.04±0.13 | 1.89±0.11 | 1.45±0.11 |
| 60 days | | | | | |
| $S_1$ | 2.02±0.14 | 1.46±0.11 | 1.89±0.13 | 2.61±0.12 | 1.93±0.09 |
| $S_2$ | 1.25±0.14 | 1.54±0.16 | 2.22±0.11 | 2.53±0.09 | 2.21±0.11 |
| $S_3$ | 3.01±0.12 | 1.18±0.14 | 2.04±0.15 | 2.56±0.11 | 2.55±0.16 |
| $S_4$ | 1.34±0.11 | 1.57±0.13 | 1.66±0.17 | 2.37±0.15 | 1.81±0.13 |
| F-Ratio (columns, storage period) | 0.45 | 2.7 | 50.8 | 3.0 | 1.3 |
| CD (5%) | - | 0.237 | 0.343 | - | - |
| F-Ratio (Rows, Treatments) | 38.3 | 130.3 | 17.2 | 32.2 | 17.4 |
| CD (5%) | 0.366 | - | 0.343 | 0.359 | 0.312 |

The product developed with four modifications were $S_1$ (With RWF), $S_2$ (RWF: DSF (4:1), $S_3$ ($S_2$ + 2.5/5% CLP) and $S_4$ ($S_3$ + 2.5/5% AP). *Mathi* and *shakarpara* contained 7.5% CLP and 5% AP, whereas

in saviyan and bhujia mix the supplementation level of CLP and AP was 2.5% each. In biscuits both powders were added at 5% level. Samples were stored in zip pouches at room temperature for 60 days. Further products were analyzed at an interval of 0, 30, 45 and 60 days for peroxide and free fatty acid values (Cox and Pearson, 1962), total sugar (Dubois *et al*, 1956), reducing sugar (Nelson, 1944) and non-reducing sugar by the difference in the concentration of total sugar and reducing sugar. The samples were statistically analyzed using analysis of variance (ANOVA).

## Results and Discussion

The length of storage period altered the chemical composition of supplementary foods. As the storage period increased the peroxide value and free fatty acids also increased. Among the products highest increase at 0 to 60$^{th}$ day for peroxide value was found in *mathi* (2.7 to 4.5 mEq / kg in $S_1$) and minimum in biscuits (3.2 to 4.3 mEq / kg). Maximum increase in free fatty acid value was found in control from 0 to 60$^{th}$ days. *Mathi* had highest increase in free fatty acid value (0.12 to 0.20 %) and minimum in *bhujia mix* (0.12 to 0.22) accept *shakarpara*. But in the case of *shakarpara* maximum increase was found in $S_2$ replication (0.10-0.45). This increase in free fatty acid and peroxide value showed that both type of rancidity i.e. oxidative and hydrolytic took place during storage period (Joshi and Nath, 2002). Peroxide value is oxidative absorption of $O_2$ in fat / oil.

With increase in storage period peroxide value of products increased significantly. Higher peroxide value indicates higher degree of $O_2$ absorption. Acid value is an indicative of free fatty acid present in the product. Results revealed that with increase in storage period, the acid value in the form of free fatty acid increased significantly. Higher the acid value more will be FFA and shelf life thus will be less. Similar findings have been observed by Singh and Jha (2005) who reported an increase in FFA value of *shrikhand* at 0, 5, 10, 15 and 20 days of storage period. The reported increase was observed in FFA value as 0.23, 0.34, 0.45, 0.79 and 1.52 %, respectively. Results are also supported by Semwal *et al* (2005) who studied the peroxide value and free fatty acid value of fried sweet *boondi* at 0, 30, 60, 120, 180 and 245 days of storage period. The peroxide value of *boondi* was 3.6, 4.8, 6.5, 9.2, 12.6 nd 18.7 meq $O_2$ / kg fat and free fatty acid value as 0.35, 0.40, 0.68, 0.81, 0.94 and 1.26 % oleic acid, respectively indicating an increase in peroxide and acid value which reduces the acceptability of fried products with increased storage period.

The increase in total sugars at 60th day of storage for $S_1$ of all products, the values were ranged between 25.6±0.14 to 26.0±0.12 and 39.8±0.12 to 40.5±0.14, being minimum in sav*i*yan and maximum in *shakarpara*.. The total sugar content for $S_2$ of all products ranged from 28.4±0.13 to 29.7±0.15 (*saviyan*) and 29.8±0.12 to 32.7±0.10 (*mathi*). Similar trend was followed for $S_3$ and $S_4$ modification of each product. Sweet products i. e. *shakarpara*, *bhujia* mix and biscuits had the higher total sugar content as compared to salty ones. The increase in total sugar might be assigned to the hydrolysis of complex carbohydrates (Saika and Saika, 2002).

Deka *et al* (2004) studied the impact of storage on total sugar content of lime-*aonla* spiced beverage. A gradual increase in total sugar was found as 8.8, 10.1, 10.6 and 10.6 % at 0, 2, 4 and 6 months respectively. Reducing sugars were found to decrease with an increase in storage period. The decrease in reducing sugars till 60$^{th}$ day of storage for $S_1$ modification of *mathi* ranged between 28.5±0.10 to 28.1±0.08, similar trend followed for all modifications of each product. Premavalli *et al* (2001) analyzed reducing sugar content in carrot-pumpkin *halwa* packed in polypropylene (PP) at 0, 1, 2, 3 and 4 months storage period to be 25.5, 32.5, 39.5, 63.5 and 45.9 g glucose / 100g, respectively. The change in reducing sugar and total carbohydrate are accounted for on the basis of acid catalyzed sucrose hydrolysis mechanism. This involves the protonation of glucose oxygen followed by glycosic bond to form mono saccharides in the form of carbonium ion. Fructose carboxinium ($Fru^+$) reacts with water to form two fructose units and another fructose to form difructose phenolic (PPCC) coloured compound. These changes occurred for gradual rise in the color reducing and reducing sugar (Jones and Smith, 1999).

The increase in non-reducing sugars from 0 to 60$^{th}$ day of storage for $S_1$ of all products was 1.32±0.12 to 2.02±0.14 (*mathi*), 0.81±0.12 to 1.46±0.11 (*shakarpara*), 0.48±0.07 to 1.89±0.13 (*saviyan*), 0.61±0.11 to 2.61±0.12 (biscuits) and 0.32±0.17 to 1.93±0.09 (*bhujia* mix). Similar trend was followed for all modification of each developed supplementary foods.

Singh *et al* (2000) analyzed reducing sugar, non-reducing sugar and total sugar in soy fortified biscuits. The corresponding values were found to be 1.93, 18.9 and 20.9%, respectively.

## Conclusion

An increase in peroxide value, FFA and sugars was observed with an increase in storage period.

Maximum increase was observed in $S_1$ as a control for peroxide value and free fatty acid. The highest increase was observed at 60th day in all modification of each product. In the case of total sugars the highest increase at 60th day was recorded for each product. The maximum reduction in reducing sugar of all products was analyzed at 60th day of storage period. In the case of non-reducing sugars, all the products had maximum increase till 60th day of storage. With increase in storage period, total and reducing sugars showed non significant increase, whereas non reducing sugars, free fatty acids and peroxide value showed significant increase ($p<0.05$). Hence, developed value added products can be easily prepared and stored at domestic level and if incorporated in daily diet can significantly reduce the micronutrient deficiency.

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*Original Article*

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# Bones and Joints Related Health Problems Among Menopausal Women

**Raut Sonali S.*, NalwadeVijaya M.****

**Abstract**

The present study was undertaken to collect the information on bone and joint related health problems, exercise pattern and common calcium rich source - milk consumption by using developed questionnaire. Data was statistically analyzed. Bones and joint related health problem such as knee pain followed by leg and waist pain were perceived by more number of selected menopausal women. A relatively very high per cent of premenopausal and menopausal women had problem of weight gain. It was also reported that more number of premenopausal women was having habit of exercise than that of premenopausal and postmenopausal women. Walking as an exercise was followed by maximum number of menopausal women. Habit of consumption of milk was reported by 135 menopausal women. It was noticed that 45 per cent of menopausal women had the habit of consuming milk and majority of them were found to be consuming milk once a week.

**Keywords:** Menopausal Women; Bone Problems; Exercise and Milk Consumption.

## Introduction

Menopause is the permanent cessation of menstruation resulting from the loss of follicular activity of the ovaries (WHO, 1996) which is recognized to have occurred after 12 consecutive months of amenorrhea, for which there is no other obvious pathological or physiological cause (Goyal *et al*., 2009; Achie *et al*., 2011; Khokhar *et al*., 2012; and Lotfi *et al*., 2012).

It is an established fact that a well-balanced diet is important for good health and may also provide other benefits, such as alleviating the severity of some menopause-related symptoms (Francesca, 2011). Diet plays an important role in the reduction of menopausal symptoms. Even regular exercise benefits the heart, bones and to maintain ideal body weight which contributes to a sense of overall wellbeing and improvement in mood.

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Calcium and soy isoflavones are two essential nutrients on top of the list for women's health. Calcium is the most important bone builder mineral used in the prevention and treatment of osteoporosis. Isoflavones are natural phytoestrogens found in many foods which tailor the menopausal therapy in a natural way (Carusi, 2000 and Goyal *et al*., 2009). Phytoestrogens resemble estrogens in structure and function. They bind weakly to estrogens receptor which predominates in breast, uterus and ovary cells and it binds strongly to receptor which predominates in prostrate, bone and vascular tissue. Phytoestrogens exert organ specific estrogenic or anti-estrogenic effect by blocking the estrogen receptors and possessing weak estrogenic activity (Goyal *et al*., 2008).

## Materials and Methods

A total sample of 300 menopausal women between 40 and 60 years of age was selected for the study. Purposive sampling technique was used comprised of 100 premenopausal, 100 premenopausal and 100 postmenopausal women.

The survey was conducted to collect the information on bone and joint related health problems among the selected menopausal women, exercise pattern followed by menopausal women and common calcium source milk consumption pattern.

Statistical analysis was carried out by applying 't' and 'z' tests to know the difference among anthropometric measurements, haemoglobin content and serum calcium content. The statistical significance between different parameters were tested by adopting students 't' test (Panse and Sukhatme, 1988).

## Results and Discussion

Information regarding bones and joints related health problems perceived by the selected menopausal women is presented in Table 1. All the selected menopausal women were divided in equal number based on menopausal stage as premenopausal (100), premenopausal (100) and postmenopausal women (100) and surveyed to collect the information on bones and joint related health problems, exercise pattern and milk consumption pattern among selected menopausal women.

Bones and joints related health problems mostly perceived by menopausal women were knee pain (43%) followed by waist pain (37%), leg pain (34%) and back pain (29%) which was significantly higher among postmenopausal women than that of premenopausal and premenopausal women. All bones and joint related problems except ankle problem were highly prevalent among postmenopausal women than that of premenopausal and premenopausal women. Whereas, ankle pain was perceived by significantly more per cent of premenopausal women (18%) than that of premenopausal women (4%) and more among postmenopausal women (14%) than that of premenopausal women (4%). On the other hand, the incidence of fracture was significantly more among postmenopausal women as compared to premenopausal and premenopausal women.

Statistical analysis showed that all the bones and joints related health problems were found to be significantly more among postmenopausal women than that of premenopausal women and in premenopausal women as compared to premenopausal women. Besides these significant differences were seen among postmenopausal women and premenopausal women in regard to prevalence of knee pain, waist pain, shoulder pain, all joint pain and incidence of fracture was also noticed.

**Table 1:** Bones and Joints Related Health Problems Perceived by the Selected Menopausal Women

| Physiological symptoms | Per cent of menopausal women | | | | | |
|---|---|---|---|---|---|---|
| | Premenopausal (n=100) a | Premenopausal (n=100) b | Postmenopausal (n=100) c | a vs. b | b vs. c | a vs. c |
| Legs | 13 | 31 | 34 | 5.46** | 0.66$^{NS}$ | 5.87** |
| Knees | 16 | 28 | 43 | 3.80** | 2.96* | 5.96** |
| Ankles | 4 | 18 | 14 | 7.85** | 1.81$^{NS}$ | 7.17** |
| Waist | 7 | 26 | 37 | 7.22** | 2.47* | 8.09** |
| Back | 5 | 22 | 29 | 7.74** | 1.96$^{NS}$ | 8.32** |
| Shoulder | 0 | 5 | 12 | 11.18** | 5.67** | 10.44** |
| All joints | 0 | 2 | 6 | 14.14** | 7.07** | 10.95** |
| Incidence of fracture | 1 | 4 | 8 | 8.66** | 4.85** | 9.35** |

NS- non significant *- significant at 5 % level ** - significant at 1 % level

The problems regarding bone and joint pain were found in more per cent of menopausal women which may be attributed to decline the level of estrogen during menopause stage. The body's ability to keep up with the natural process of bone resorption and bone turnover also declines as bone mass decreases. With the onset of menopause, rapid bone loss occurs which is believed to average approximately 2 to 3 per cent over the following 5 to 10 years, the risk of fractures increases being greatest in the early postmenopausal years. Life time losses may reach 30 to 40 per cent of the peak bone mass in women which leads to osteoporosis. Besides these prolonged amenorrhea, low calcium diet, lack of exercise and vitamin D deficiency also causes the bone and joint related problems.

Frequency of consumption of milk by the selected menopausal women is presented in Table 2. It was found that 55, 38 and 42 premenopausal, and postmenopausal women were having the habit of consuming milk. More number of premenopausal women (22) had the habit of consuming milk daily as compared to premenopausal (15) and postmenopausal women (12). Even similar trend was noticed in following weekly consumption of milk pattern. On the other hand, more number of postmenopausal women (15) was found to be consuming milk one to three times in a month followed by premenopausal women (13) and premenopausal women (11).

In conclusion, it can be said that more number of premenopausal women had the habit of consumption of milk as compared to premenopausal and postmenopausal women. More per cent of premenopausal women (22%) were found to be consuming milk daily than that of postmenopausal and premenopausal women. Similar trend was also noticed in weekly consumption of milk. Among all the selected menopausal women, more number of premenopausal women had the habit of consuming milk weekly as compared to premenopausal and postmenopausal women. On the other hand, it was found that more number of postmenopausal women were having habit of consumption of milk monthly one to three times than premenopausal and premenopausal women.

**Table 2:** Frequency of Milk Consumption by Selected Menopausal Women

| Particulars | Premenopausal (n=100) | Per cent of menopausal women | |
|---|---|---|---|
| | | Premenopausal (n=100) | Postmenopausal (n=100) |
| **Daily** | | | |
| One time | 12 | 13 | 7 |
| Two time | 10 | 2 | 5 |
| **Weekly** | | | |
| One time | 12 | 10 | 9 |
| Two time | 5 | 5 | 1 |
| Three time | 2 | 0 | 2 |
| Four time | 1 | 1 | 3 |
| **Monthly** | | | |
| One time | 4 | 3 | 7 |
| Two time | 9 | 6 | 6 |
| Three time | 0 | 2 | 2 |
| **Total** | 55 | 38 | 42 |

Even Geeta *et al.,* (2011) found that the milk consumption was more among premenopausal women than that of premenopausal and postmenopausal women. On the contrary, the results of Farida *et al*., (2009) and Pon *et al*., (2006) indicated that milk intake was more among postmenopausal women than that of premenopausal women. Prevailing exercise pattern among the selected menopausal women is presented in Table 3. More number of premenopausal women (46) was having habit of exercise than that of premenopausal (35) and postmenopausal women (25).In case of frequency of exercise daily, twice a week and thrice a week were significantly more among premenopausal women than that of premenopausal and postmenopausal women. While once in a week exercise pattern were followed more by premenopausal women than those of premenopausal women and more by postmenopausal women as compared to premenopausal women was observed.

In case of duration of exercise it was found that 15 minutes duration of exercise was done by significantly more postmenopausal women, 30 minutes by more premenopausal women and 45 minutes by more premenopausal women which was significant statistically. One hour duration for exercise was followed by significantly more number of premenopausal women than that of postmenopausal women.

It was found that walking as an exercise was followed by maximum number of premenopausal women (37). Maximum numbers of premenopausal women (18) were carrying out exercise for one hour duration. Frequency of exercise was found to be three times a week in maximum number of premenopausal women (16). Similar trend also was noticed among premenopausal women. In regard to exercise pattern it was noticed that maximum number of premenopausal women (37) were performing walking as an exercise. The frequency of exercise was noticed to be thrice a week in more number of premenopausal women (23). Majority of premenopausal women (18) were carrying out exercise for one hour duration followed by 45 minutes (11). In case of premenopausal women majority of women (19) were carrying out exercise for one hour followed by 30 minutes (15).Even in case of postmenopausal women majority (17) were performing walking and more number (10) of them were doing exercise three times in a week. However, majority (12) of them were doing exercise for only 15 minutes and none of them were found to be performing exercise for one hour duration.

Results indicated that more per cent (46) of premenopausal women had a habit of daily exercise as compared to premenopausal and postmenopausal women. All the three groups of menopausal women were having the significant difference in case of 15 minutes, 30 minutes and 45 minutes of exercise

duration except one hour duration of exercise which was significant in premenopausal women Vs postmenopausal women and premenopausal Vs postmenopausal women.

**Table 3:** Prevailing Exercise Pattern among the Selected Menopausal Women

| Particulars | Per cent of menopausal women | | | a vs. b | b vs. c | a vs. c |
|---|---|---|---|---|---|---|
| | Premenopausal (n=100) | Premenopausal (n=100) | Postmenopausal (n=100) | | | |
| **Habit of Exercise** | | | | | | |
| Yes | 35 | 46 | 25 | 1.92 NS | 4.06** | 2.36* |
| **Type of exercise** | | | | | | |
| Walking | 22 | 37 | 17 | 3.54** | 4.99** | 1.84 NS |
| Yoga | 7 | 6 | 4 | 1.17 NS | 3.08** | 4.08** |
| Walking and yoga | 6 | 3 | 4 | 5** | 2.35** | 3.08** |
| **Frequency of exercise** | | | | | | |
| Daily | 10 | 14 | 5 | 2.42* | 6.33** | 4.76** |
| Once a week | 8 | 4 | 7 | 4.85** | 4.08** | 1.01 NS |
| Twice a week | 1 | 5 | 3 | 8.94** | 3.92** | 8.16** |
| Thrice week | 16 | 23 | 10 | 2.56* | 5.32** | 3.3** |
| **Duration** | | | | | | |
| 15 min | - | 5 | 12 | 11.18** | 5.67** | 10.44** |
| 30 min | 6 | 15 | 9 | 5.8** | 3.57** | 2.97** |
| 45 min | 11 | 7 | 4 | 3.24** | 4.08** | 6.33** |
| 1 hour | 18 | 19 | - | 0.39 NS | 10.27** | 10.28** |

NS- non significant *- significant at 5 % level ** - significant at 1 % level

On the whole, it can be said that only one third of the menopausal women had the habit of doing exercise. Moderate exercise has a modest effect on preventing postmenopausal bone loss. Sedentary women suffer more from chronic back pain and insomnia. They often have poor blood circulation, weak muscles and loss of bone mass as immobilization can decrease bone mass. Just like muscles, bones adhere to the "use it or lose it rule". During exercise hormones called endorphins are released in the brain. They are "feel good" hormones involved in body's positive response to stress. Testosterone, a potent steroid hormone, increases muscle mass, which in turn helps to build bone density. When one exercises, the body releases testosterone, which is a natural antidote to bone loss. Therefore menopausal women should have the habit of exercise to maintain her own health.

## Summary and conclusion

The per cent prevalence of all the bones and joints related health problems were significantly higher in postmenopausal women than those of premenopausal women except ankle pain. One third of the total selected menopausal women were having the habit of exercise. Habit of consumption of milk was reported by 135 menopausal women.

Every woman must have an understanding that menopause is an inevitable stage and therefore one has to be conscious about diet, exercise and good to oneself under this stage by having positive attitude towards life. Beside these, modifications in lifestyle are necessary.

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# Varietal Differences in Physicochemical and Cooking Quality Characteristics of Selected Rice (*Oryza Sativa L.*) Grains

**Vijayalaxmi Kamaraddi*, Jamuna Prakash****

**Abstract**

Grain quality characteristics of selected rice varieties were analyzed for physicochemical and cooking quality traits and compared with local check Rajamudi. The rice varieties selected for the study were IET 13901, KHP-5, KHP-10, KHP-2 and Rajamudi, released from Agricultural Research Station (Paddy), Mudigere. Length and breadth of reported varieties ranged from 5.63-5.84 and 1.85-2.73. The highest L/B ratio was observed with KHP-2 (3.18) followed by local check Rajamudi (3.13) and medium slender grain IET 13901 (2.53). Kernel elongation ratio ranged between 1.62 (KHP-2 ) to 1.85 (Rajamudi) and was found to be highest in Rajamudi followed by IET 13901 (1.84). The varieties had alkali degradation score ranging from 4.56 to 5.47 with intermediate gelatinization temperature (69°–74°C). All the tested varieties had intermediate amylose content including local check ranging between 20.42 (Rajamudi) and 27.18 (KHP-10). The present study revealed that among the ruling varieties tested IET-13901 and KHP-10 showed desirable quality parameters followed by KHP-5 and KHP-2 when compared with local check. These varieties could be effectively utilized in quality improvement program in rice.

**Keywords:** Length-Breadth Ratio; Amylose Content; Gel Consistency; Alkali Score; Water Uptake Profile; Expansion Characteristics.

## Introduction

Rice is life for Asians in general and Indians in particular. Asia cultivates 137 million hectare of rice, of which India's share is 45 million hectare. Rice contributes to 15% annual GDP of India and provides 75% of calorie requirement and 55% of protein requirement for more than 70% of Indians [1]. Rice provides more calories per hectare than any other cereal crop. Its nutritional level is high among cereals and other grains. Though the protein content of the rice is less than that of wheat, the true protein digestibility and biological value of rice protein are the highest among wheat and other cereals. Rice occupies a pivotal place in India's food and livelihood security system. Traditionally, plant breeders concentrated more on breeding for high yields and disease / pest resistance. Recently the trend has changed to incorporate preferred quality characteristics that increase the total economic value of rice.

Rice quality is a complex trait comprising many physicochemical characteristics. All consumers want the best quality that they can afford. With many countries achieving self- sufficiency in rice production, the demand by consumer for better quality rice has increased. Milling out turn is one of the important properties to the millers. The rice millers prefer varieties with high milling and head rice out turn, whereas consumer preference depend on physicochemical, cooking and eating qualities [2].

Head rice recovery varies depending on many factors [3]. Size and shape are also important factors for consumers. Preference for grain size and shape vary from one group of consumer to another [4]. The amylose content of rice is the main parameter of cooking and eating qualities [5]. Amylose content, volume expansion and water absorption characteristics influence many of the starch properties of rice [6]. Cooking time is important as it determines tenderness of cooked rice as well as stickiness to a

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greater extent. The higher the water imbibition ratio of rice, the lower will be the energy content per unit volume or weight of cooked rice as they will have more water and less solid materials.

Rice production technologies regarding high yielding varieties are now well developed in most of the countries in Asia for maximum production. Hence it is the need of the hour to develop rice varieties with high yield with improved quality. It is urgently needed to characterize the already released varieties and the promising lines in rice with special reference to their physicochemical properties.

Present investigation was undertaken with an objective to characterize five selected rice varieties for physicochemical and cooking quality parameters.

## Materials and Methods

The different varieties of rice selected for the study were IET 13901, KHP-5, KHP-10, KHP-2 and Rajamudi. These were procured from Zonal Agricultural Research Station (Paddy), Mudigere, for the study. The local variety, Rajamudi was taken as standard local check for all the traits.

## Physical Parameters

Physical parameters like kernel length, breadth, and linear elongation ratio were recorded as per Juliano and Parez, [7]. Gelatinization temperature (GT) was observed based on alkali spreading score (ASS) of milled rice [8]. Estimation of amylose content was done as per simplified procedure of Juliano [9]. Gel consistency was analyzed based on the method given by Cagampang et al., [10]. The details of grading physical parameters are compiled below.

Physical characters: Kernel length and kernel length / breath ratio was used to classify the grains as given below.

| Kernel length | | Kernel length/breath ratio | |
|---|---|---|---|
| Size | Length (mm) | Shape | L/B ratio |
| Extra long | >7.50 | Slender | >3.0 |
| Long | 6.61–7.50 | Medium | 2.1–3.0 |
| Medium | 5.51–6.60 | Bold | 1.1–2.0 |
| Short | <5.50 | Round | <1.0 |

Cooking quality was determined by linear elongation ratio, which was the ratio of mean length of cooked rice to mean length of milled rice [7].

## Chemical characters

Gelatinization temperature (GT) was observed based on alkali spreading score (ASS) of milled rice [8]. The appearance and disintegration of kernels was rated visually based on the following 7 point numerical spreading scale [6]. Kernel with a score of 5.5–7.0 was classified as '*low GT'* (55–69°C), 3.5–5.4 as '*intermediate GT'* (69–74°C), 2.6–3.4 as '*intermediate to high GT'* and 1.0–2.5 as '*high GT'* (74.5–80°C ) types.

| Score | Spreading | Alkali digestion |
|---|---|---|
| 1 | Kernel not affected | Low |
| 2 | Kernel swollen | Low |
| 3 | Kernel swollen, collar incomplete or narrow | Low / intermediate |
| 4 | Kernel swollen, collar complete or wide | Intermediate |
| 5 | Kernel split or segmented, collar complete and wide | Intermediate |
| 6 | Kernel dispersed, merged with collar | High |
| 7 | Kernel completely dispersed | High |

## Amylose content

Simplified procedure of Juliano [9] was used for the estimation of amylose content. Based on amylose content rice was classified (5) as follows–

| Variety | Amylose content (%) | Description |
|---|---|---|
| Waxy (Amylose content <2.0%) | 1–2 | Waxy |
| Non-waxy (Amylose content >2.0) | > 2–9 | Very low |
| | >9–20 | Low |
| | >20–25 | Intermediate |
| | >25–33 | High |

Gel consistency was tested based on the method described by Cagampang et al., [10]. The test classified the rice into two categories**.**

| | Length of gel | Description | Gel consistency |
|---|---|---|---|
| 1. | <40mm | Very flaky rice | Hard |
| 2. | 40-60mm | Flaky rice | Medium |
| 3. | >60mm | Soft rice | Soft |

Equilibrium moisture content (EMS-S) on soaking was determined as per Swamy et al., [11]. Rice samples were soaked in distilled water at room temperature. Portions were withdrawn at 0, 15, 30 and 60 min and at 3, 18, and 24 hours. These were pressed thoroughly between filter paper to remove surface moisture and dried in oven at 40° C for 24 hours. The moisture content was determined by repeated weighing.

## Statistical Treatment

The data were subjected to Analysis of Variance to determine the level of significance between rice varieties for different parameters. The probability level was fixed at 0.05.

## Results and Discussion

Salient features of rice varieties are compiled in Table 1 to indicate the year of release of the crop, the grain type and color, yield of the grain and duration of growing. The grain yield for all released varieties was more than the local check Rajamudi. The number of days for one variety was lesser but two of them required slightly longer time to harvest. On the whole, the characteristics were similar to the local variety with advantage of higher yield.

**Table 1:** Salient Features of The Selected Rice Varieties

| Sl.No. | Variety | Year of release | Grain type | Grain colour | Grain yield Quintal/ hectare | Duration type | No. of days |
|---|---|---|---|---|---|---|---|
| 1. | IET-13901 (Tunga) | 2002 | Long slender | White | 50 –55 | Long | 155-160 |
| 2. | KHP-5 | 2000 | Medium bold | Red | 50 –55 | Long | 170-175 |
| 3. | KHP-10 | 2004 | Medium bold | White | 50 –50 | Long | 170-175 |
| 4. | KHP-2 | 1990 | Long bold | White | 52 –55 | Medium | 150-155 |
| 5. | Rajamudi | Local check | Medium slender | White | 40 –42 | Medium | 155-160 |

## Physical characteristics of raw rice varieties

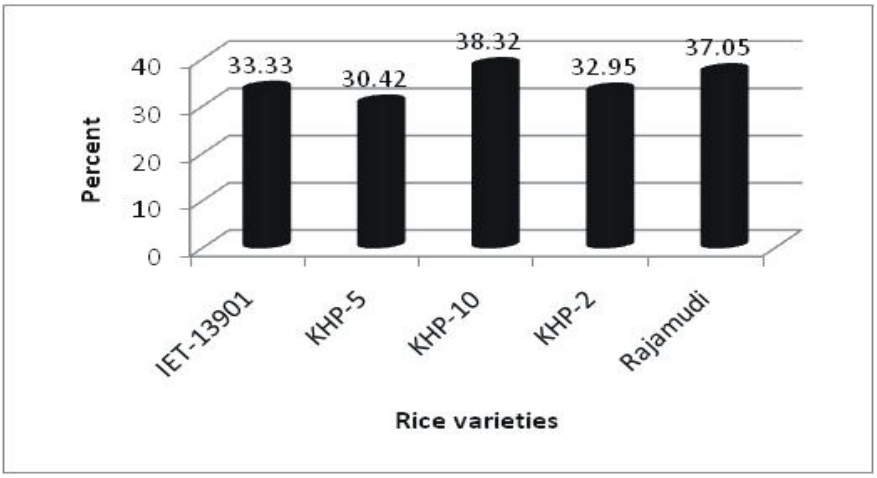
Grain size, shape, length, breadth, thickness and length / breadth ratio were determined based on the consumer preference and these are presented in Table 2. Highest kernel length of 5.84 mm was observed in KHP-5 followed by IET-13901 (5.83) and KHP-2, while lower kernel length was observed in Rajamudi (5.63 mm). Kernel of KHP-5 and KHP-10 were medium bold while those of KHP-5, long bold and IET 13901, long slender followed by Rajamudi as medium slender. Highest length and breadth ratio were observed in KHP-2 (3.18) followed by Rajamudi (3.13) and IET-13901 (2.3). Length and breadth of the genotypes analyzed in the study ranged from 5.63 to 5.84 mm and 1.93 to 2.73 mm respectively. Grain thickness varied from 1.35 mm (Rajamudi) to 1.75 mm (IET-13901). Cultivars differ in the thickness of aleurone layers. Coarser, bolder, short grain cultivars tend to have more thickness than medium and slender long grain varieties.

Equilibrium moisture content (EMC) of tested varieties has been depicted in Fig. 1. EMC of the varieties ranged between 30.42–38.32. The variety, KHP-10 had highest EMC values followed by local check Rajamudi and the lowest values were observed in KHP-5 (30.42).

**Table 2:** Physical Characteristics of Raw Rice

| Characteristics | Rice varieties | | | | | F Ratio | P Value |
|---|---|---|---|---|---|---|---|
| | IET- 1390 | KHP-5 | KHP-10 | KHP-2 | Rajamudi | | |
| Length (mm) | 5.83 ± 0.038 | 5.837 ± 0.160 | 5.797 ± 0.273 | 5.825 ± 0.037 | 5.625 ± 0.029 | 1.51833 | $0.245^{ns}$ |
| Breadth (mm) | 2.33 ± 0.038 | 2.725 ± 0.038 | 2.53 ± 0.038 | 1.925 ± 0.379 | 1.85 ± 0.034 | 414.707 | 0.000*** |
| Thickness (mm) | 1.75 ± 0.023 | 1.545 ± 0.017 | 1.70 ± 0.041 | 1.475 ± 0.038 | 1.35 ± 0.034 | 104.386 | 0.000*** |
| L/B Ratio | 2.527 ± 0.015 | 2.192 ± 0.009 | 2.34 ± 0.023 | 3.177 ± 0.129 | 3.13 ± 0.047 | 208.576 | 0.000*** |

**Fig.1:** Equilibrium Moisture Content of Rice Varieties



## Cooking Characteristics of Rice Varieties

Elongation ratio of the entries ranged from 1.52–2.01 (Table 3). It is an important parameter for cooked rice. If rice elongates more lengthwise, it gives a finer appearance and if expands girth-wise, it gives a coarse look. The elongation ratio was high in KHP-5 (2.01) followed by Rajamudi (1.85) and (IET-13901 (1.84). Similar results were reported by Biswas et al., and Dipti et al., [12, 13].

The volume expansion ratio of most of the tested varieties was more than 2.5 and it is considered as a positive quality feature especially for the lower income group for whom quality is important criteria. However, higher the volume expansion ratio of rice, lower will be the energy content per unit per volume or unit of cooked rice as they will have more water content and less solid material.

**Table 3:** Characteristics of Cooked Rice Varieties

| Characteristics | Rice varieties IET- 1390 | KHP-5 | KHP-10 | KHP-2 | Rajamudi | F Ratio | P Value |
|---|---|---|---|---|---|---|---|
| Water uptake profile | | | | | | | |
| Water uptake At 80°C | 0.345 ± 0.029 | 0.25 ± 0.012 | 0.33 ± 0.012 | 0.422 ± 0.029 | 0.462 ± 0.03 | 49.0251 | 0.000*** |
| Water uptake At 90°C | 2.435 ± 0.040 | 2.397 ± 0.017 | 1.638 ± 0.033 | 2.137 ± 0.026 | 2.44 ± 0.024 | 547.419 | 0.000*** |
| Water uptake Ratio | 14.72 ± 0.480 | 9.835 ± 0.033 | 19.175 ± 0.044 | 21.025 ± 0.026 | 19.04 ± 0.018 | 1734.32 | 0.000*** |
| Expansion characteristics | | | | | | | |
| Kernel elongation ratio | 1.84 ± 0.023 | 2.01 ± 0.009 | 1.522 ± 0.020 | 1.62 ± 0.029 | 1.85 ± 0.024 | 300.879 | 0.000*** |
| Volume expansion ratio | 2.85 ± 0.042 | 2.657 ± 0.029 | 2.522 ± 0.021 | 2.958 ± 0.043 | 3.22 ± 0.028 | 254.636 | 0.000*** |
| Elongation ratio | 2.055 ± 0.097 | 1.82 ± 0.040 | 1.525 ± 0.038 | 1.65 ± 0.024 | 2.05 ± 0.191 | 22.5251 | 0.000*** |
| Elongation index | 1.52 ± 0.022 | 1.125 ± 0.038 | 1.102 ± 0.071 | 1.225 ± 0.030 | 1.312 ± 0.010 | 72.3584 | 0.000*** |

## Chemical Characteristics of Varieties

Alkali spreading value of varieties ranged from 4.56-5.47 (Table 4). High alkali spreading value corresponded to low gelatinization temperature. Varieties with intermediate gelatinization temperature are desirable. All the tested varieties exhibited intermediate GT (69–74°C) IET-13901, (4.56); KHP-5, (4.75); KHP-10, (5.24); KHP-2, (4.92) and Rajamudi (5.47). Varieties with high amylose content cook as dry grains, less tender, and become hard upon cooling. In contrast, low amylose content rice varieties cook moist and sticky. Intermediate amylose is most preferred in India. Amylose content of tested varieties ranged from 20.64% to 27.18%. Amylose content is the major factor for eating quality of rice (14). It is an indicator of volume expansion and water absorption during cooking, and correlates with hardness, whiteness and dullness of cooked rice. Intermediate amylose content was observed in three varieties, IET-13901 (24.23), KHP-5 (20.64), KHP-2 (21.23) and Rajamudi (20.42). Highest amylose content was observed in KHP-10 (27.18) (Table 4). Amylose content of the rice determines the hardness or stickiness of cooked rice. Higher amylose content (>25%) gives non-sticky soft or hard cooked rice. Rice varieties with intermediate amylose content (20-25%) gives non-sticky, soft, flaky rice.

Gel consistency of tested varieties ranged from 31.3 to 44.3 (Table 4). Interestingly the result showed that all the varieties exhibited medium gel consistency except KHP-2 (hard gel) indicating that they are flaky rice with medium gel consistently.

**Table 4:** Amylose Content and Quality Characteristics of Rice Varieties

| Characteristics | Rice varieties IET-1390 | KHP-5 | KHP-10 | KHP-2 | Rajamudi | F Ratio | P Value |
|---|---|---|---|---|---|---|---|
| Amylose (g/100g) | 24.23 ± 0.206 | 20.84 ± 0.429 | 27.18 ± 0.207 | 21.23 ±0.155 | 20.42 ± 0.016 | 578.726 | 0.000*** |
| Alkali score | 4.55 ± 0.029 | 4.75 ± 0.495 | 5.23 ± 0.229 | 4.91 ± 0.009 | 5.47 ± 0.034 | 9.06573 | 0.0006*** |
| Gel consistency (mm) | 41.38 ± 0.144 | 43.3 ± 0.244 | 44.25 ± 0.289 | 31.25 ± 0.289 | 42.03 ± 0.411 | 1326.46 | 0.000*** |

## Conclusion

Among the ruling varieties tested, IET-13901 and KHP-10 showed desirable quality parameters followed by KHP-5 and KHP-2 when compared with local variety Rajamudi. These varieties could be effectively utilized in quality improvement program which would be helpful to develop high yielding varieties with better grain quality.

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# Development of Cookies Using Fenugreek Seed Extract as a Functional Ingredient

**Sonu, S. A. Wani, Pradyuman Kumar***

**Abstract**

Cookies were developed with fenugreek seed extract and fenugreek seed powder (FSP) as an added-value food ingredient with wheat flour. Fenugreek seed extract were encapsulated using g**um arabic**. Their physical and sensory analysis was studied. Results showed significant ($p<0.05$) difference of physical properties between control and 1-4% FSP level and 1-2% encapsulated fenugreek seed extract level. Spread ratio was found highest for those cookies where substitution was made with encapsulated fenugreek seed extract. Fracture strength was highest for 4% level of FSP, whereas encapsulated fenugreek seed extract levels showed average value of fracture strength. Sensory analysis report showed highest score for the cookies, where substitution was made with 1-2% encapsulated fenugreek seed extract, which was close to control, as compared to 1-4% FSP levels. It can be concluded that these desirable properties of cookies contained with fenugreek seed extract suggested that fenugreek seed extract can be used further in the development of quality cookies. Fenugreek seed extract possessing lot of physiological health benefits like hypoglycemic effect, hypocholestrolemic effect, possessing antioxidant activity etc. and could have higher preference over the whole seed powder of fenugreek for development and acceptability of cookies.

**Keywords**: Fenugreek; Cookies; Physical Properties; Sensory Properties; Encapsulation.

## Introduction

Fenugreek *(Trigonella foenum-graecum)* commonly known as "methi" is an annual herb of the Leguminosae family and is grown mainly in Western Asia and South Eastern Europe. India is the largest producer and the major producing states are Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Uttrakhand, Madhya Pradesh and Punjab. Both the fresh and dried leaves as well as the seeds are edible. These are used as herb, spice and vegetable. Fenugreek seeds are small having a peculiar odor, flavor and pleasantly bitter taste and are used as spice in India, China and Middle East for centuries. Fenugreek endosperm contains the highest amount of saponins (4.63 g / 100 g) and protein (43.8g / 100g) and the husk has highest polyphenol content [1]. Fenugreek seeds are known to have several pharmacological effects such as hypoglycemia [2, 3], hypocholesterolemia [4, 5], gastro-protective [6], chemopreventive [7], anti-oxidative [8], anti-inflammatory, antipyretic [9], laxative [10] and appetite stimulation attributes [11]. Fenugreek has been found to have protective effect on acute cerebral ischemia [12]. Also it has beneficial influence on digestion and also has the ability to modify food texture [13].

The bitter taste and distinct aroma of fenugreek seed limit its wider application in the food industry**.** *As bread found to be the most universal of all bakery products,* **its** fine texture, and large loaf volume require formation of an elastic dough structure. That is possible only due to presence elements possessing gluten. Gluten is present in hard wheat (12% protein). Large quantities of bakery products are consumed daily. However addition of fenugreek seed powder to wheat flour in different proportions increased the lysine, minerals, protein and dietary fibre contents proportionately to the level of substitution. Also the products, viz., noodles, biscuits, bread and macaroni prepared from the wheat–fenugreek blends at 10, 15,

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and 20% levels were found organoleptically acceptable. Fenugreek has been used earlier in bakery products such as biscuits [14] and extruded products [15].

Cookies have been suggested as a better for the carrier of fenugreek because of its relatively sweet taste, wide consumption, relatively long shelf-life and good eating quality as compared to other similar products [16]. Cookies with high sensory ratings have been produced from blends of millet / pigeon pea flour [17], green gram, Bengal gram, black gram and wheat [18], groundnut, cowpea and wheat [19] and soybean, chickpea or lupine with wheat [20]. No reports of studies were found for combinations of Wheat and fenugreek seed powder (FSP) and fenugreek seed extract. Cookies can provide a convenient vehicle for delivery of health-promoting compounds possessed in fenugreek to consumers. The aim of the present research work involves the use of fenugreek seed extract for the development of cookies with several health benefits and study the effects of fenugreek extract on cookies in terms of physical and sensory characteristics.

## Materials and Methods

The study was carried out in the Department of Food Engineering and Technology, Sant Longowal Institute of Engineering and Technology, Longowal, Punjab. The extraction of dried and ground fenugreek seeds for bioactive component was done using ultrasound assisted extraction (UAE) and microwave assisted extraction (MAE) techniques. The extracts were encapsulated and utilized in cookies preparation.

### *Procurement of Raw Material*

Fenugreek seeds of variety HM-57 were purchased from Haryana Agricultural University (HAU), Hisar, Haryana. The seeds were then inspected and cleaned manually to remove any foreign material, dirt, stones, grits, weeds etc. Ground fenugreek seeds were extracted using ultrasound assisted extraction (UAE) and microwave assisted extraction (MAE) techniques.

Wheat flour, sugar, shortening and salt were purchased from local market of Sangrur. Wheat flour was sieved to get rid of bran and other matter. Sugar was ground. Wheat flour and sugar, both were sieved through a 60-mesh screen.

### *Encapsulation*

The encapsulation of the purified extract was done by method used by Kalogeropoulos et al. [21] with certain modifications. Gum Arabica was used as an encapsulating agent.

### *Cookie Formulation*

Cookies were prepared by the formula used by Singh et al. [22] with a slight modification**.**

### *Cookie ingredients*

100 g flour (containing varying proportions of defatted FSP and encapsulated extract), 40 g sugar, 50 g shortening, 1 g sodium chloride, 0.5 g sodium bicarbonate and sufficient water to make required consistency of cookie dough.

Fine ground sugar which has been sieved was firstly creamed with the shortening and rubbed in. Wheat flour containing different proportions of FSP and encapsulated extract was mixed uniformly with sodium chloride and sodium bicarbonate, sieved and mixed with the above mixture. Water was then added to make the dough of desired consistency for cookie preparation. The dough was thinly rolled on a sheeting board to uniform thickness (3.4 mm) and cut using a round cutter to a diameter of 40 mm. The dough pieces were baked in greased pans for 15 min in a baking oven set at temperature of 160°C for above surface and 180°C for lower surface. The baked cookies were cooled for 20 min and stored in air tight container till further analyses.

## Physical Analysis of Cookie

### *Spread ratio*

Diameter (D) and thickness (T) of the five cookies from each batch were measured using a vernier caliper. Spread ratio was calculated as ratio of diameter to thickness i.e. D / T. Average values of determinations were reported.

### *Fracture strength (Snap Test)*

The snap test was conducted using a probe 3-point bending attached to texture analyzer. The distance between two beams was 30 mm. While other similar beam was brought down from above at a pre-test speed:2.0 mm / s, test speed:0.5 mm / s, post-test speed:10.0 mm / s, distance:5 mm to

contact the cookie. The downward movement was continued till the cookie broke. The peak force was reported as fracture strength.

*Sensory evaluation*

The cookies were evaluated by a panel consisting of faculty and students of the Department of Food Engineering & Technology, S.L.I.E.T., Longowal, Sangrur (India). The panelists were naïve to the project. Coded samples of cookies were served on a white disposable plastic tray and distilled water was provided for rinsing the mouth. A nine point hedonic scale with 1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely was used [23]. The members were given written instructions to score on parameters viz. appearance (dull to attractive), color (very dark brown to light brown), initial bite (hard to crisp), taste (bitter to sweet) and mouthfeel (teeth clogging to crunchy). The mean of 10 evaluations was reported.

*Statistical Analysis*

All the analysis was replicated three times. All the results were analyzed by using commercial statistical package (Trial Version, Inc., Chicago USA) for One-way analysis of variance (ANOVA) with Duncan's test which was used to determine the significant differences between the means at the 5 % level. Differences are considered statistically significant at $p<0.05$.

## Results and Discussion

The cookies prepared were supplemented with varying proportions of FSP and the purified and encapsulated fenugreek seed extract. Control sample was prepared from wheat flour only.

*Spread ratio of cookies*

Data on spread ratio and fracture strength of the cookies as affected by incorporation of defatted FSP and encapsulated extract were presented on Table 1.

**Table1:** Spread ratio of cookies

| Supplementation level (%) | Width, W (cm) | Thickness, T (cm) | Spread ratio (W /T ) | Fracture strength (g) |
|---|---|---|---|---|
| Control (wheat) | $5.44\pm0.19^{a}$ | $1.24\pm0.25^{b}$ | $4.50\pm0.12^{b}$ | $3725^{d}$ |
| 1% FSP | $5.04\pm0.16^{b}$ | $1.28\pm0.40^{a}$ | $4.35\pm0.08^{c}$ | $3825^{c}$ |
| 2% FSP | $5.08\pm0.21^{b}$ | $1.26\pm0.16^{ab}$ | $4.21\pm0.16^{d}$ | $3900^{b}$ |
| 3% FSP | $5.12\pm0.13^{b}$ | $1.29\pm0.05^{ab}$ | $4.17\pm0.05^{d}$ | $3925^{b}$ |
| 4% FSP | $5.02\pm0.08^{b}$ | $1.27\pm0.05^{a}$ | $4.14\pm0.06^{d}$ | $4750^{a}$ |
| 1% encapsulated extract of FSP | $5.44\pm0.09^{a}$ | $1.19\pm0.04^{b}$ | $5.06\pm0.21^{a}$ | $3795^{c}$ |
| 2% encapsulated extract of FSP | $5.6\pm0.2^{a}$ | $1.2\pm0.14^{b}$ | $5.17\pm0.16^{a}$ | $3800^{c}$ |

Values are means of ten independent samples. Values not sharing a common superscript in a column are significantly ($p<0.05$) different.

In general, supplementation affected width, thickness and spread ratio. The width of the cookies decreased significantly ($p<0.05$) with the addition of FSP as compared to control, while encapsulated extract of FSP showed non-significant change. The thickness of cookies increased with addition of FSP, while encapsulated extract of FSP didn't show any change. The width and thickness of the control (100 % wheat flour) was 5.44 cm and 1.24 cm respectively. Diameter (width) varied from 5.02 to 5.12 cm and thickness varied from 1.26 to 1.29 cm due to addition of FSP. The changes in the thickness and width were reflected in spread ratio. Spread ratio of the cookies was found to be reduced with increase in level of FSP. The spread factor of the control sample was 4.50 cm. A decrease in the value of spread ratio was observed from 4.35 to 4.14 cm with the increase in level of supplementation of FSP. This could be due to competition of water between FSP and wheat flour for dough consistency. As the composite flours contain more number of hydrophilic sites available, which competes for the limited free water in cookie dough and apparently forms aggregates. As fenugreek contains high amount of fibre, the fibre competes for free water present in the dough leading to increased dough viscosity and thereby limiting cookie spread. Similar results were reported by Hooda and Jood [14] when supplemented FSP in varying proportions with wheat flour for preparation of cookies. Cookies having higher spread ratios are considered most desirable [24]. Similarly other researcher's also observed that height of supplemented biscuit increased, whereas width and spread ratio decreased with the increasing levels of fenugreek flour [25, 26]. A significant ($p<0.05$) increase in the value of spread ratio was observed

with the addition of encapsulated extract of FSP. The spread ratio of the cookies containing the encapsulated extract of FSP was found higher than the control sample. The value of the spread factor observed was 5.06 for 1% encapsulated extract of FSP and 5.17 for 2% encapsulated extract of FSP. This could be due to encapsulation. Gum acacia used for the encapsulation of fenugreek seed extract have the property to retain high water content which helps in high spread ratio during baking.

*Effect of supplementation on hardness of the cookies*

Inclusion of FSP increased the hardness of the cookies. A significant ($p<0.05$) increase in the value of hardness was observed upon further addition of FSP as indicated in the Table 1. The fracture strength of the control sample was 3725 g. The fracture strength of the cookies increased progressively from 3825 to 4750 g with increase in supplementation level of FSP. On the other hand cookies supplemented with encapsulated extract were found to have lower hardness values than the cookies supplemented with FSP. The lower hardness values of cookies supplemented with encapsulated extract is in correspondence with the higher spread ratio of the cookies. Product containing 4% FSP showed the maximum value for hardness. This could be due to lower spread ratio of the cookies, indicating that lower spread ratio leading to higher hardness. The increase in hardness of the cookies containing FSP can also be contributed to lower fat content of the supplemented flour as the FSP used was defatted.

*Sensory evaluation of the cookies*

The effects of supplementation of cookies with FSP and encapsulated extract on the sensory characteristics of the cookies are presented in Table 2. A 9-point hedonic scale was used where 9 indicated like extremely and 1 indicated dislike extremely. The data was statistically analyzed by Duncan's test. With change in supplementation level, the sensory factors like color, appearance, taste, mouthfeel and initial bite showed a significant change. Higher level of FSP (i.e. 3% and 4% FSP) showed fewer score than other samples as indicated by sensory panel. The appearance at higher level i.e. 4% FSP showed significant ($p<0.05$) lower score for the product. This may be due to high FSP giving darker image to the product. Replacement of flour with 3% and 4% FSP significantly ($p<0.05$) impaired the taste of the cookies as indicated in Table 2, a significant decrease in the value from 7.29 to 5.86 as FSP was increased. This may be due to the bitter taste of fenugreek seeds and this bitterness was highest for 4% supplementation of FSP. Sensory panel gives the highest score to the cookies supplemented with encapsulated extract of FSP.

The sensory value for mouth feel decreased significantly ($p<0.05$) with increase in level of supplementation. The control sample had 7.57 score which decreased to 5.65 for 4% FSP. This can be due to the bitter taste of FSP and this bitterness increased with increase in the supplementation of FSP. The difference in the scores for initial bite was not considerable acceptable for 4% supplementation level of FSP.

**Table 2:** Sensory Data for Cookies

| Supplementation level (%) | Color | Appearance | Taste | Mouthfeel | Initial bite | Overall acceptability |
|---|---|---|---|---|---|---|
| Control (wheat) | 7.07±0.8$^a$ | 7.06±0.82$^a$ | 7.43±1.1$^a$ | 7.57±0.53$^a$ | 7.21±0.7$^a$ | 7.07±0.65$^a$ |
| 1% FSP | 7.21±0.9$^a$ | 7.06±0.82$^a$ | 7.29±0.7$^a$ | 6.86±0.63$^b$ | 7.29±0.7$^a$ | 6.38±0.54$^b$ |
| 2% FSP | 7.29±0.3$^a$ | 7.14±0.69$^a$ | 7.29±0.4$^a$ | 6.86±0.69$^b$ | 7.14±0.6$^a$ | 6.19±0.12$^b$ |
| 3% FSP | 6.86±0.8$^b$ | 7.17±0.74$^a$ | 6.71±0.9$^b$ | 6.43±0.98$^c$ | 7.00±0.5$^a$ | 5.67±0.23$^c$ |
| 4% FSP | 6.36±1.3$^b$ | 6.56±1.50$^b$ | 5.86±1.2$^c$ | 5.86±1.35$^d$ | 6.71±0.9$^b$ | 4.28±0.67$^d$ |
| 1% encapsulated extract of FSP | 7.21±0.7$^a$ | 7.27±0.74$^a$ | 7.79±0.7$^a$ | 7.43±0.79$^a$ | 7.43±0.4$^a$ | 7.02±0.76$^a$ |
| 2% encapsulated extract of FSP | 7.21±0.7$^a$ | 7.2±0.68$^a$ | 7.86±0.6$^a$ | 7.57±0.54$^a$ | 7.57±0.5$^a$ | 7.04±0.65$^a$ |

Values are means of ten samples ± SD. Values not sharing a common superscript in a column are significantly ($p\leq 0.05$) different.

The control sample showed the maximum score for overall acceptability which was 7.07. The values decreased sharply with increase in FSP level. The score values for 1% and 2% FSP were not significantly different. This score decreased from 6.38 for 1% FSP to 4.28 for 4% FSP supplementation. The overall acceptability of the cookies supplemented with 1% and 2% encapsulated extract of FSP has score values similar to control sample. Even 2% of encapsulated extract of FSP had the highest overall acceptability among all the samples considered for the study.

## Conclusion

Fenugreek seed extract is possessing lot of physiological health benefits like hypoglycemic effect, hypocholestrolemic effect, possessing antioxidant activity, lactation stimulant, immunomodulator etc. So it can be used as value added food ingradient, which provides advantageous health benefits. Cookies prepared using fenugreek seed extract showed improved physical and sensory properties. These desirable properties of fenugreek seed extract suggested that fenugreek seed extract can be used further in the development of quality cookies. Future research could investigate strategies to improve the quality of cookies containing high levels of FSP as well as fenugreek seed extract.

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*Original Article*

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# Quality Parameters of Fruit Cheese Developed Using Pineapple Pomace

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**Abstract**

Fruit pomace, a byproduct of fruit juice industry is a rich source of nutrients and bioactive components hence, the study explored the utilization potential of pomace from pineapple for chemical composition and product formulation. Results revealed that pineapple fruit pomace had fair amounts of nutrients and was rich in dietary fiber (insoluble fiber: 29.45% and soluble fiber: 2.27% on dry weight basis). Pomace was also an excellent source of antioxidant components such as total carotenoids, β-carotene and polyphenols. Pineapple fruit cheese prepared using pineapple pomace was a good source of carotenoids and it could be stored for a period of 30 days both at low and refrigerated temperature. The products had acceptable organoleptic quality. Hence, it can be concluded that pineapple pomace, a byproduct of pineapple juice industry can be used as a potential source of antioxidants rich ingredient for value added product.

**Keywords:** Nutritional Composition; Antioxidants; Carotenoids; Dietary Fiber; Sensory Quality.

## Introduction

India is a very large producer of fruits and vegetables, second only to China and Brazil. The current production of fruits in India is estimated to be more than 85million tons, of which pineapple accounts for nearly 3 lakh tons [1]. Fruits and vegetables are good dietary sources of several nutrients. Fruit and vegetable pomace or residue left after the extraction of juice is inexpensive, easily available waste material which comprises of bioactive molecules. Earlier studies have indicated that fruit and vegetable peels or residues can be rich source of dietary fiber, antioxidant components and exhibit bioactive potential [2,3,4]. Hence, such bio-waste materials need to be explored for their possible utilization in product formulations. Studies reported in this area include the incorporation of cauliflower trimmings into ready-to-eat expanded products and their effect on the textural and functional properties of extrudates by Stojceska et al [5], utilization potential of feijoa fruit wastes as ingredients for functional foods [6] and juices, and fibers and skin waste extracts from white, pink or red-fleshed apple genotypes as potential food ingredients [7]. Nassar et al,[8] prepared biscuits from blends containing different proportion of orange peel or pulp as it contained high amount of dietary fiber. In another study by Shyamala et al, [9] dehydrated peels of ridge gourd (*LuffaAcutangula*) was used for development of a high fiber snack product. Furthermore, fiber-rich byproducts can be incorporated into food products as inexpensive, non-caloric bulking agents for partial replacement of flour, fat or sugar, as enhancers of water and oil retention and to improve oxidative stabilities [10]. Accordingly agricultural wastes of plant origin have attracted considerable attention as potential sources of bioactive phenolics, which can be used for various purposes in the food ingredients and other value added bio-products. Thus functional foods represent an important part of the overall food market. Hence, in the present study, pineapple pomace was screened for its proximate composition, antioxidant components and utilization for a shelf stable product development. The formulated product was also evaluated for nutritional quality, sensory parameters and storage stability.

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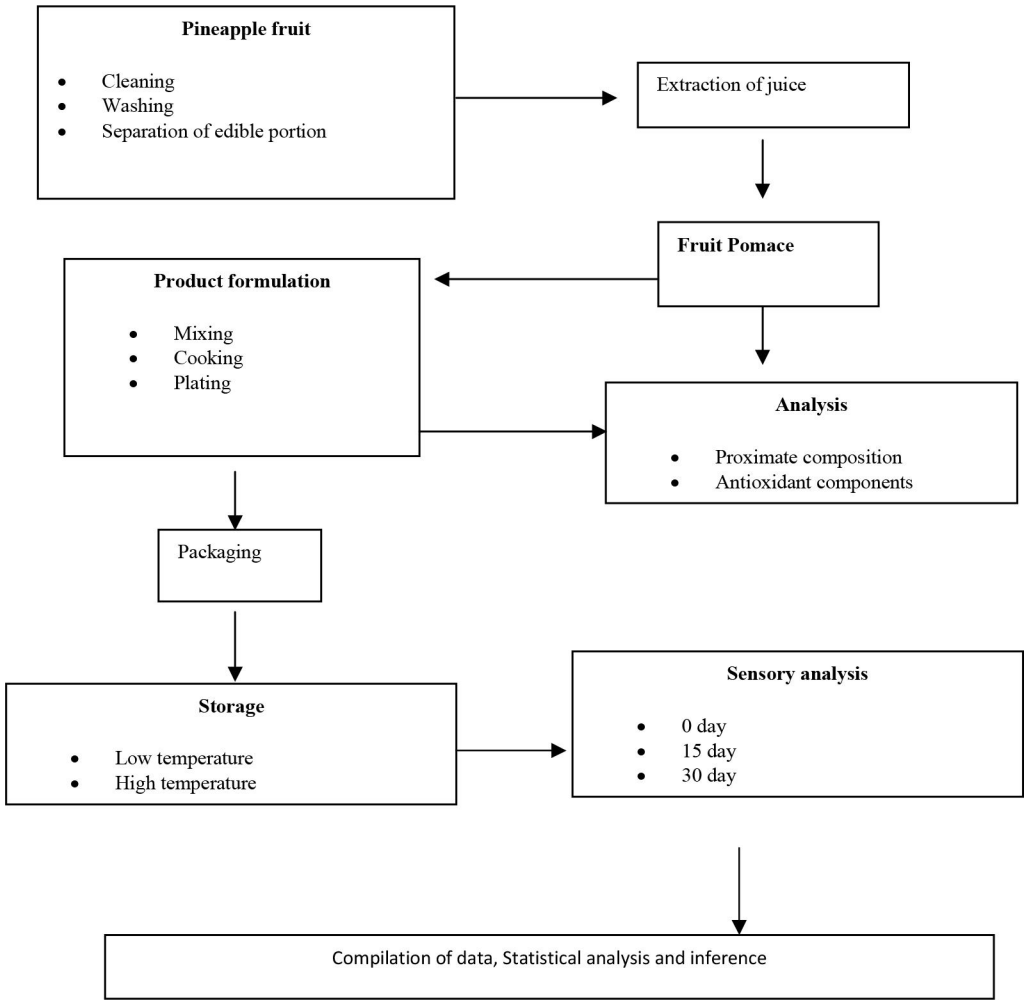
## Materials and Methods

*Material Procurement and Preparation*

Ripe pineapple (*Ananas comosus*) for the study were purchased from local market, Mysore, India in one lot. Fruits were washed, cleaned and edible portion was separated manually using a sharp knife. Fruit pomace was obtained in the laboratory by extracting the juice from the edible portion and the left over pomace i.e. the pulp left after juice extraction was taken for further analysis as well as product development. A record of yield was maintained. An overall study design is presented in Fig. 1.

**Fig. 1:** Study Design




*Chemical Reagents*

Chemicals used for the study; L-Ascorbic acid and β-carotene were from Sigma (Sigma-Aldrich, USA) Chemical Co, and all others were obtained from E-Merck, Mumbai or Qualigens Fine Chemicals, Mumbai, India. All chemicals were of analytical grade. Double glass distilled water was used for all analysis. All analysis were run in triplicates and averaged.

*Determination of Proximate Composition*

Pineapple pomace and the formulated product were analyzed for proximate composition by standard methods described below. Moisture was estimated by vacuum oven (method 926.12, 41.1.02) procedure. Total ether extractives were estimated by Soxhlet apparatus using petroleum ether for extraction (method 948.22, 40.1.05) with the solvent being evaporated and the residue weighed to determine the fat content. Protein was determined by Kjeldahl nitrogen determination and conversion to protein using a factor of 6.25 (method 960.52, 12.1.07). Ash by direct analysis (method 942.05,4.1.10) was determined according to the

Association of Official Analytical Chemists. [11] Dietary fiber consisting of insoluble (IDF) and soluble fractions (SDF) was estimated by the enzymatic gravimetric method of Asp et al, which is equivalent to physiologically indigestible fiber residue [12]. Carbohydrate was computed by difference. While naturally pineapple is rich in sugar, fruit cheese had more of carbohydrate content both on fresh and dry weight basis due to added sugar.

*Estimation of Antioxidant Components*

Ascorbic acid was estimated by 2, 6-dichlorophenol indophenol visual titration method, which is based on reduction of the dye color from blue to pale pink by ascorbic acid [13]. For estimation of carotenoids, the powdered samples were extracted in acetone and transferred to petroleum ether phase. Total carotene was read colorimetrically using petroleum ether for baseline correction. β-carotene was separated by column chromatography and read colorimetrically [13]. Samples were analyzed for total polyphenol content as tannic acid equivalent (TAE) / 100 g of sample according to the Folin-Ciocalteu method. [14] The total flavonoid content was determined using the Dowd method using a standard curve with quercetin as the standard and expressed as mg of quercetin equivalent / 100 g of sample [15].

*Product Development, Sensory and Storage Studies*

The pineapple cheese was prepared using fruit pomace (1 kg), sugar (1.5 kg), butter (125 g) and citric acid (a pinch). All the ingredients were heated in a pan with constant stirring and a pinch of citric acid dissolved in water was added at about 100º C. The formulation was heated till the mass fell in the form of flakes when dropped from the wooden ladle (110-120ºC). The thick mass was then allowed to set on a plate greased with butter after which it was cut into uniform pieces and wrapped in butter paper. The products were stored both at room temperature and low temperature (fridge) in airtight PET (polyethylene terephthalate) containers. These were evaluated for sensory parameters on initial day, 15$^{th}$ day and 30$^{th}$ day as detailed below.

Pineapple cheese was subjected to sensory analysis by semi-trained panel members (n=30) who were familiar with sensory analysis techniques. A score card was developed specifically for the product based on qualitative descriptive analysis of Stone and Sidel [16]. This particular method of sensory evaluation is a combination of the descriptive profiling and scoring method to get an overall assessment of the product profile and this does not require a trained panel like other descriptive methods. The score card carries a 15 cm scale for each of the quality attribute namely, appearance, color, texture, taste and overall quality. The scale is denoted by lower and higher quality description of each attribute at both ends. The respondents indicated their choice by marking on a scale which was converted to numerical score later.

*Statistical Analysis*

The data were analyzed for mean and standard deviation. Data on sensory analysis of products were subjected to ANOVA and a further post-test (Tukey's) to determine significant differences in samples, if any.

## Results and Discussion

*Proximate Composition*

For utilization of fruit pomace, pineapple fruit cheese was prepared using the leftover pulp after

**Table 1:** Proximate Composition of Pineapple Pomace and Fruit Cheese

| Constituents | Pineapple residue | Fruit Cheese | Pineapple residue | Fruit Cheese |
|---|---|---|---|---|
| | Fresh weight basis (g/per 100g) | | Dry weight basis (g/per 100g) | |
| Moisture | 83.06±0.00 | 8.76±0.12 | - | - |
| Protein | 0.74±0.03 | 1.64±0.09 | 4.36 | 1.79 |
| Ash | 0.46±0.03 | 0.12±0.00 | 2.71 | 0.13 |
| Ether extractives | 0.22±0.28 | 5.91±0.08 | 1.35 | 6.47 |
| Insoluble dietary fiber | 4.99±0.06 | 2.08±0.02 | 29.45 | 2.27 |
| Soluble dietary fiber | 0.11±0.07 | 0.18±0.00 | 0.64 | 0.19 |
| Carbohydrate (by difference) | 10.42 | 81.31 | 61.49 | 89.15 |

juice extraction. Fresh pineapple pomace as well as the product was analyzed for its proximate composition and the results are presented in Table 1. Pineapple pomace had high moisture content of 83%. Insoluble fiber (29.45 g/100g) was high in pomace compared to the soluble fiber (0.64 g/100g). Protein content was 4.36 g/100g. Ether extractive was high in pomace i.e. 2.29 g/100g. Moisture content of the formulated product was 8.76 g/100g, protein 1.79 g/100g, total fiber 2.46 g/100g, ether extractives 5.91 g/100g and ash content was low i.e. 0.13 g/100 g. The moisture content was low due to added dry ingredients and processing. Low moisture content contributed to shelf stability of product. A higher fat content can be attributed to butter, which was added during reparation. Butter is known to enhance the texture of dishes by providing lubricity and it also adds to the flavor of product.

*Antioxidant Components*

Selected antioxidant components were analyzed in fruit pomace and product and results are compiled in Table 2. Ascorbic acid was estimated to be 10.74 mg/100g in the pomace and 8.19 mg/100g in the prepared product. Percentage loss of ascorbic acid was marginal in the product as it retained up to 70% even after heat processing, hence fruit cheese was a fair source of ascorbic acid. Pineapple pomace was a rich source of carotenoids, with total and β-carotene values of 6189 and 4082 µg/100g respectively. As a result, even product exhibited fair amounts of total (247 µg/100g) and β-carotene (101 µg/100g). Total flavonoid was 7 mg QE/100g in pomace and 2.17 mg QE/100g in the product. Total polyphenols was also high in pomace (87.0mg TAE/100g) whereas the product had around 20.0 mg TAE/100g of total polyphenols. Fruit cheese are products which provide many nutrients other than plain energy unlike other sugar candies, hence, these can be safely given to children. Nida and Prakash reported formulation of iron fortified fruit cheese with pineapple and guava fruit which were highly acceptable and exhibited high iron bio-accessibility [17]. Recent research also shows that many antioxidant components are bound to dietary fiber and they get released in the gastrointestinal tract on account of enzyme action. This is especially true for fruits as they are rich in fiber and contain many bioactive components [18].

**Table 2:** Antioxidant Components of Pineapple Pomace and Fruit Cheese

| Constituents | Pineapple residue | Fruit Cheese | Pineapple residue | Fruit Cheese |
|---|---|---|---|---|
| | Fresh weight basis (per 100g) | | Dry weight basis (per 100g) | |
| Ascorbic acid (mg) | 1.82±0.01 | 7.48±0.26 | 10.74 | 8.19 |
| Total Carotene (µg) | 1048±53.41 | 225±6.88 | 6189 | 247 |
| β-Carotene (µg) | 694±9.04 | 92±5.60 | 4082 | 101 |
| Total Flavonoid (mg QE) | 1.19±0.07 | 1.98±0.14 | 7.02 | 2.17 |
| Total Polyphenol (mg TAE) | 14.76±0.06 | 18.25±0.35 | 87.13 | 20.00 |

*Sensory and Storage Studies*

Sensory analysis was carried out using 30 semi-trained panel members. Product was evaluated at 0, 15 and 30 day's storage period. The product was kept in PET at both low and room temperatures. As explained earlier, a 15 cm scale was used for sensory scores (Stone and Sidel 1993) [15]. The results of sensory analysis conducted for product throughout the storage period are presented in Table 1. There was no difference for the sensory quality and appearance in the fresh and stored samples with the scores in the range of 8.88 to 9.60. In case of color there was a slight difference between the fresh and stored product, though the low temperature stored product retained the original color for 15 days. Taste quality was given a significantly higher score for the fresh sample in comparison to all stored ones, which could have been due to smaller flavor changes on account of storage. Texture showed a slight difference only in the 30 day stored samples compared to fresh and 15 day stored products. In case of fibrous texture there was no significant difference observed. Since the product was prepared using only the pomace, this quality was also judged separately, and it was uniformly liked by all panel members. Overall acceptability of the product was 12 for the 0 day and it was around 10 for the 15 days stored products both at RT and LT storage. However the mean score was around 9 for the products stored up to 30 days at both RT and LT. Thus, it can be said that fruit cheese could be stored for a period of 15 days with no major differences in the organoleptic quality, after which there were lower scores for some of the sensory attributes. It may be noted that this drawback can be overcome by selecting a better packaging material. Since this was an initial trial, only butter paper was

**Table 3:** Sensory Attributes of Fruit Cheese (Mean Scores ± S.D)

| Treatments | 0 day | Room temperature | Low temperature | Room temperature | Low temperature |
|---|---|---|---|---|---|
| | | 15 day | | 30 day | |
| Appearance | 9.60 ±1.91 [a] | 9.60±1.43 [a] | 9.41±1.60 [a] | 8.88±1.50 [a] | 8.96±1.61 [a] |
| Color | 9.89±1.76 [a] | 9.04±1.39 [b] | 9.55±1.74 [a] | 8.79±1.65 [b] | 8.85±1.34 [b] |
| Taste | 12.27±1.06 [a] | 9.98±1.59 [b] | 10.50±1.77 [b] | 9.62±2.18 [b] | 10.12±2.05 [b] |
| Texture | 9.44±2.23 [a] | 9.50±1.57 [a] | 9.40±1.47 [a] | 8.24±1.40 [b] | 8.56±1.44 [b] |
| Texture (fibrous) | 6.10±2.61 [a] | 7.21±2.67 [a] | 7.28±2.59 [a] | 6.68±2.98 [a] | 7.28 ±2.43 [a] |
| Aroma | 11.90±1.31 [a] | 9.71±1.98 [b] | 10.41±1.78 [b] | 10.43±1.54 [b] | 10.01±1.66 [b] |
| Overall acceptability | 12.20±1.48 [a] | 10.07±1.97 [b] | 10.90±1.69 [b] | 9.86±2.01 [b] | 9.94±1.77 [b] |

Figures with different superscripts in a row are significantly different from each other on application of Turkey's test.

used to wrap the cheese, this gives room for water vapor transmission and air ingress causing texture and flavor changes in the product on storage.

## Conclusion

A higher intake of fruits and vegetables is advised for the innumerable benefits they impart to maintain health and prevent diseases. While fresh fruits can be consumed on a daily basis, they are perishable commodity and need to be converted to many processed products to increase the shelf stability. The process of conversion results in many byproducts which have a utilization potential. The nutritional compositional analysis of fruit pomace indicated that they were good source of protein, dietary fiber in particular, the soluble fiber, ascorbic acid and carotenoids. It can be concluded that the pomace from fruits of the juice industry could be utilized as a source for value addition as these were rich in phenolic components. Hence, this study indicates the potential of utilizing fruit pomace in product formulation.

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**Standard journal article**

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006;35:540-7.

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**Article in supplement or special issue**

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997;195 Suppl 2:3-9.

**Corporate (collective) author**

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000;71:1792-801.

**Unpublished article**

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**Reference from electronic media**

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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