Development and Evaluation of Functional and Nutritional Properties of Composite Flours

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ABSTRACT

The functional properties like water absorption capacity, swelling capacity, oil absorption capacity, emulsion activity, emulsion stability, foam capacity, foam stability and bulk density were evaluated. The moisture content of composite flours is ranged from 3.93 to 8.60% among all the flours. The highest moisture content was observed in T6 composite flour (8.60%) while lowest was in T1 wheat flour or control (3.93%). The composite flour was prepared in different composition and ratio. The WAC of the flour varied from 113 to 127.40% among all the types of composite flours. The highest water absorption capacity was observed in T6 composite flour (127.40%) while lowest was in T1 wheat flour or control (113%). Swelling capacity of composite flour decreased with decreasing. Swelling capacity of the composite flours is also affected due to moisture of the flour and ratio of individual flours, texture and particles size of the flour.

INTRODUCTION

Composite flour are better utilized for cookies production rather than for bread because of their ready-to eat form, relatively prolonged shelf-life, wide consumption and good eating quality. Cookies based on rye, barley, rice, maize, acha, amaranth and oat flour have been reported by several researchers. Protein enrichment studies on cookies have been carried out using brewer’s spent grain [15] and some legumes, which are generally good source of proteins. Supplementation of wheat flour with different proportions of bambara groundnut flour for biscuit production had also been investigated [14]. The concept of composite technology initiated by the Food and Health Organization (FAO) in 1964 was targeted reducing the cost of support for temperate countries by encouraging the use of indigenous crops such as cassava, yam, maize and others in partial substitution of wheat flour [40]. The FAO reported that the application of composite flour in various food products would be economically advantageous if the imports of wheat could be reduced or even eliminated, and that demand for bread and pastry products could be met by the use of domestically grown products instead of wheat [21]. The bakery products produced using composite flour were of good quality, with some characteristics similar to wheat-flour bread, though the texture and the properties of the composite flour bakery products were different from those made from wheat flour, with an increased nutritional value and the appearance. Apart from being a good source of calories and other nutrients, wheat is considered nutritionally poor, as cereal proteins are deficient in essential amino acids such as lysine and threonine [12]. Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown crops as flour [19, 17]. Thus, several developing countries have encouraged the initiation of programmes to evaluate the feasibility of alternative locally
available flours as a substitute for wheat flour [1]. Wheat is an important cereal because it can be used for preparation of many products, bread is one of the least expensive most important staples in the world, because of their high popularity and large consuming, bakery products (including bread) could be a vehicle to improve the quality and nutritive value, bread considered the one of the simplest food manufactured, and its characteristics may differ from country to country [2].

Semolina particle size is a key factor in cookies making. Fine semolina gives a higher yield upon milling and is preferred by the cookies industry since it shows a high hydration rate an permits a homogeneous hydration, thus facilitating the mixing process [29]. Fine semolina is also particularly suitable for modern high speed extrusion processes, characterized by limited dough residence time, and confers to cookies a highly homogeneous colour with a higher yellow colour saturation than coarse semolina [27].

The bran and germ of oats also rich in phytochemicals i.e. tocopherols, tocotrienols, phenolic compounds and plant sterols, thought to have a beneficial effect on health (oats for health booklet) [49]. Oat meal cuts the risk of strokes and heart attacks from blocked arteries, stabilizes blood sugar and increases the body’s ability to fight off infectious disease [6].

Barley flour is rich in dietary fiber (beta glucan), which helps to lower cholesterol by binding to bile acids and removing them from the body via the faeces, magnesium and selenium. Barley is one of the richest and cheapest sources of plant protein that can be used to improve the diet of millions of people, especially the poor and low income earners in developing countries [45]. The risk posed by free radicals and oxidation products generated during cellular metabolism could be lowered by consuming foods rich in phenolics which include barley [42].

Corn is richer in oil than any other cereal crop except oat and millet [13]. Corn is also richer in vitamin A and ash contents, particularly the yellow varieties [4]. It is high in calorie, carbohydrate, protein, potassium, sodium, chlorine and sulphur [13]. When considered as a whole, protein of corn is still low in lysine, very low in tryptophan but reasonably fair in sulphur containing amino acids such as methionine and cysteine [3].

Pearl millet (Pennisetumthephyroides) is an important coarse cereal crop in western India. In 2011, 46% of pearl millet produced was used for food, 37.5% for cattle feed, 7.7% for poultry feed, 8.8% for alcohol industry and as low as 0.4% for seed purpose [5]. While, pearl millet is nutritious, it is underutilized in developed countries due to non-availability in convenient/ ready to eat form [33, 35].

Finger millet (Eleusinecoracana) also known as ragi, nachni or Nagli is one of the important millets in India. It is one of the most nutritious and healthy cereals with high protein and mineral contents [48]. It is also rich in magnesium, phosphorous, potassium, iron and has been reported to have 5-30 times the calcium content found in other cereals [11, 23, 47]. Ragi flour will provide many health benefits like ragi for losing weight, bone health, lowering blood cholesterol, for anaemia and other health conditions [30].

Mung beans (Vignaradiata) are legumes that are small, ovoid in shape and green in colour. They are also known as green gram or golden [10]. The protein content of mung bean is about 24% [24]. Mung bean is rich in vitamin A, B1, B2, niacin vitamin C, potassium, phosphorus and calcium [37]. Green beans (Phaseolus vulgaris) are one of the most important vegetable protein crops of very rich in minerals, good source of fat soluble vitamins and many antioxidants/ phytochemicals which has an important roles in health maintenance [44, 18, 41]. Carrot (Daucuscarota L.) is one of the important nutritious root vegetables grown throughout the world. It is an excellent source of phytonutrients such as phenolics, polyacetylenes and carotenoids [8, 16, 9]. Carrots are one of the best sources of β-carotene. The carotene content of carrots ranges from 60–120 mg/100 g, but some varieties can reach up to 300 mg/100 g [46].

Guava (Psidiumguajava L.), now being recognized as “super food” is getting very much attention in the agro-food business due to the attractive characteristics of the fruit, such as health promoting bioactive components, functional elements. The fruit is considered as highly nutritious because it contains a high level of ascorbic acid (50-300 mg/100 g fresh weight) and has several carotenoids such as phytofluene, β-carotene, β-cryptoxanthin, γ-carotene, lycopene, rubixanthin, cryptoflavin, lutein, and neochrome [25]. Phenolic compounds such as myricetin and apigenin [26], ellagic acid, and anthocyanins [28] are also at high levels in guava fruits.

**MATERIALS AND METHODS**

Raw materials viz., Wheat flour, Semolina, Barley flour, Corn flour, Bajra flour, Ragi flours and packaging material (glass jar) purchased from local market of Meerut. Mung bean flour, Carrot powder, Guava powder and Oat flour were prepared in Process and Food Engineering Laboratory of the Department of Agricultural Engineering at Sardar Vallabh Bhai Patel university of Agriculture and Technology, Modipuram, Meerut.

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Analysis of functional properties

In present study of various types of functional properties of composite flours before preparation of cookies was analysed i.e. water absorption capacity (%), swelling capacity (ml), oil absorption capacity (%), emulsion activity (%), emulsion stability (%), foam capacity (%), foam stability (%) and bulk density (g/cc).

The emulsion activity and stability by [50] described and followed as the emulsion (1 g sample, 10 ml distilled water and 10 ml soybean oil) was prepared in calibrated centrifuged tube. The foam capacity (FC) and foam stability (FS) by [32] were determined as described with slight modification. The swelling capacity was determined by the method described by [34]. The water absorption capacity of the flours was determined by the method of [43]. Oil absorption was examined as percent oil bound per gram flour. The volume of 100 g of the flour was measured in a measuring cylinder (250 ml) after tapping the cylinder on a wooden plank until no visible decrease in volume was noticed, and based on the weight and volume, the apparent (bulk) density was calculated [22]. The oil absorption capacity was determined by the method of [43].

Chemical properties

The crude protein was estimated by micro Kjeldahl Method [7]. The ash Content was estimated by [38]. Crude fiber estimated by employing standard method of analysis [7]. Moisture content of the sample was determined by standard air oven method [38]. Fat content was determined by [31]. The total energy content (kcal) of the sample was obtained by [36]. The samples of cookies will be crushed with equal quantity of distilled water and the pH will determined using digital pH meter after calibration with standard buffers of 4 and 7 [39]. Carbohydrate content of the flour samples was determined by using the formula described by [20]. The Optical density is the measurement of light that is absorbed by any material when a beam of light falls on it. According to the Bear’s law the intensity of a beam of monochromatic light decreases exponentially as concentration of absorbing substance increases. Mathematically, O.D. of medium is given by following formula.

\[ \text{Optical Density} = \log \frac{I_0}{I_i} \]

Where,

\( I_o \) = Intensity of the incident light
\( I_i \) = Intensity of light transmitted through the medium.

Optical density of a sample would be determined by using method as recommended by [38].

RESULTS AND DISCUSSION

Functional properties of composite flours

Composite flour was prepared by blending wheat flour with Semolina, Barley flour, Corn flour, Bajra flour, Ragi flour, Oat flour, Mung bean flour, Carrot powder and Guava powder in ratios of \( T_1 = 100:0:0:0:0:0:0:0:0:0 \), \( T_2 = 91:1:1:1:1:1:1:1:1:1 \), \( T_3 = 82:2:2:2:2:2:2:2:2:2 \), \( T_4 = 73:3:3:3:3:3:3:3:3:3 \), \( T_5 = 64:4:4:4:4:4:4:4:4:4 \) and \( T_6 = 55:5:5:5:5:5:5:5:5:5 \) respectively for further experiment and presented in Table 1 and Table 2. The composite flour was prepared in different composition and ratio.

In present study of various types of functional properties of flours before preparation of cookies was analyzed i.e. water absorption capacity (%), swelling capacity (ml), oil absorption capacity (%), emulsion activity (%), emulsion stability (%), foam capacity (%), foam stability (%) and bulk density (g/cc). The effect of incorporation proportions of different flours on the functional properties of composite flours were analyzed and presented in Table 1.

The composite flour was prepared in different composition and ratio. The WAC of the flour varied from 113 to 127.40% among all the types of composite flours. The highest water absorption capacity was observed in \( T_6 \) composite flour (127.40%) while lowest was in \( T_1 \) wheat flour or control (113%). Water absorption capacity of composite flour increased with increasing. WAC of the composite flours is also affected due to moisture of the flour and ratio of individual flours and texture of flour.

The swelling capacity of the flour varied from 32 to 30.80 ml among all the types of composite flours. The highest swelling capacity was observed in \( T_1 \) wheat flour or control (32 ml) while lowest was in \( T_6 \) composite flour (30.80 ml). Swelling capacity of composite flour decreased with decreasing. Swelling capacity of the composite flours is also affected due to moisture of the flour and ratio of individual flours, texture and particles size of the flour.

The oil absorption capacity of the flour ranged from 108 to 103% among all the types of composite flours. The highest oil absorption capacity was observed in \( T_1 \) wheat flour or control (108%) while lowest was in \( T_6 \) composite flour (103%). Oil absorption capacity of composite flour decreased with decreasing. Oil absorption capacity of the composite flours is also affected due to moisture of the flour and ratio of individual flours, texture and particles size of the flour.
The emulsion activity of the flour varied from 7.72 to 10.10% among all the types of composite flours. The highest emulsion activity was observed in T_6 composite flour (10.10%) while lowest was in T_1 wheat flour or control (7.72%). Emulsion activity of composite flour increased with increasing. Emulsion activity of the composite flours is also affected due to protein content and carbohydrate of the individual flour.

The emulsion stability of the composite flour ranged from 26 to 121.64% among all the types of composite flours. The highest emulsion stability was observed in T_6 composite flour (121.64%) while lowest was in T_1 wheat flour or control (7.72%). Emulsion stability of composite flour decreased with decreasing. Emulsion stability of the composite flours is also affected due to protein content and carbohydrate of the individual flour.

The foam capacity of the composite flour ranged from 26 to 10.10% among all the types of composite flours. The highest foam capacity was observed in T_6 composite flour (10.10%) while lowest was in T_1 wheat flour or control (8%). Foam capacity of composite flour decreased with decreasing. Foam capacity of the composite flours is also affected due to protein content and carbohydrate of the individual flour.

The foam stability of the composite flour ranged from 26 to 10.10% among all the types of composite flours. The highest foam stability was observed in T_6 composite flour (10.10%) while lowest was in T_1 wheat flour or control (5.56%). Foam stability of composite flour decreased with decreasing. Foam stability of the composite flours is also affected due to protein content and carbohydrate of the individual flour.

The bulk density of the flour varied from 0.769 to 0.790 g/cc among all the types of composite flours. The highest bulk density was observed in T_1 wheat flour or control (0.790 g/cc) while lowest was in T_6 composite flour (0.769 g/cc).

Table 1: Functional properties of composite flour

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Water absorption capacity (%)</th>
<th>Swelling capacity (ml)</th>
<th>Oil absorption capacity (%)</th>
<th>Emulsion activity (%)</th>
<th>Emulsion stability (%)</th>
<th>Foam capacity (%)</th>
<th>Foam stability (%)</th>
<th>Bulk density (g/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_1</td>
<td>113.00±5.650</td>
<td>32.00±1.600</td>
<td>108.00±5.400</td>
<td>7.72±0.386</td>
<td>5.56±0.278</td>
<td>26.00±1.300</td>
<td>8.00±0.240</td>
<td>0.769±0.038</td>
</tr>
<tr>
<td>T_2</td>
<td>115.88±4.635</td>
<td>31.80±1.200</td>
<td>107.00±4.280</td>
<td>8.20±0.328</td>
<td>6.86±0.274</td>
<td>25.04±1.002</td>
<td>7.73±0.309</td>
<td>0.773±0.031</td>
</tr>
<tr>
<td>T_3</td>
<td>118.76±7.126</td>
<td>31.50±1.900</td>
<td>106.00±4.583</td>
<td>8.67±0.520</td>
<td>8.15±0.489</td>
<td>24.08±1.445</td>
<td>7.46±0.448</td>
<td>0.778±0.047</td>
</tr>
<tr>
<td>T_4</td>
<td>121.64±5.731</td>
<td>31.30±0.700</td>
<td>105.00±4.400</td>
<td>9.15±0.732</td>
<td>9.45±0.756</td>
<td>23.12±1.850</td>
<td>7.19±0.575</td>
<td>0.782±0.063</td>
</tr>
<tr>
<td>T_5</td>
<td>124.52±3.736</td>
<td>31.00±1.000</td>
<td>104.00±3.120</td>
<td>9.62±0.289</td>
<td>10.75±0.322</td>
<td>22.16±0.665</td>
<td>6.92±0.208</td>
<td>0.786±0.024</td>
</tr>
<tr>
<td>T_6</td>
<td>127.40±5.096</td>
<td>30.80±1.200</td>
<td>103.00±4.120</td>
<td>10.10±0.404</td>
<td>12.04±0.482</td>
<td>21.20±0.848</td>
<td>6.65±0.266</td>
<td>0.790±0.032</td>
</tr>
</tbody>
</table>

Table 2: Physico-chemical properties of composite flour

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture Content (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Crude Fibre (%)</th>
<th>Ash (%)</th>
<th>pH</th>
<th>Carbohydrate (%)</th>
<th>Energy (Kcal)</th>
<th>Optical density</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_1</td>
<td>3.93±0.306</td>
<td>13.65±0.117</td>
<td>3.65±0.083</td>
<td>4.36±0.060</td>
<td>2.14±0.122</td>
<td>6.81±0.062</td>
<td>72.27±0.368</td>
<td>376.52±1.697</td>
<td>0.013±0.0032</td>
</tr>
<tr>
<td>T_2</td>
<td>8.53±0.611</td>
<td>13.62±0.146</td>
<td>3.61±0.043</td>
<td>4.35±0.035</td>
<td>1.30±0.265</td>
<td>6.50±0.020</td>
<td>68.61±1.016</td>
<td>361.33±3.102</td>
<td>0.070±0.0017</td>
</tr>
<tr>
<td>T_3</td>
<td>7.87±0.231</td>
<td>13.49±0.190</td>
<td>3.59±0.126</td>
<td>4.40±0.056</td>
<td>1.57±0.153</td>
<td>6.26±0.015</td>
<td>69.18±0.111</td>
<td>363.05±0.631</td>
<td>0.076±0.0006</td>
</tr>
<tr>
<td>T_4</td>
<td>7.93±0.115</td>
<td>13.54±0.083</td>
<td>3.58±0.038</td>
<td>4.44±0.045</td>
<td>1.47±0.115</td>
<td>5.94±0.025</td>
<td>69.23±0.358</td>
<td>363.26±0.764</td>
<td>0.083±0.0006</td>
</tr>
<tr>
<td>T_5</td>
<td>8.40±0.200</td>
<td>13.52±0.406</td>
<td>3.54±0.033</td>
<td>4.50±0.052</td>
<td>1.57±0.153</td>
<td>5.81±0.015</td>
<td>68.76±0.516</td>
<td>360.99±0.176</td>
<td>0.098±0.0012</td>
</tr>
<tr>
<td>T_6</td>
<td>8.60±0.346</td>
<td>13.45±0.098</td>
<td>3.51±0.061</td>
<td>4.56±0.035</td>
<td>1.93±0.416</td>
<td>5.77±0.015</td>
<td>68.31±0.746</td>
<td>358.60±3.036</td>
<td>0.101±0.0010</td>
</tr>
</tbody>
</table>

T_1 = Wheat Flour (100%)
T_2 = Wheat Flour (91%), Semolina (1%), Oat Flour (1%), Barley Flour (1%), Corn Flour (1%), Ragi Flour (1%), Mung Bean (1%), Carrot Powder (1%), Guava Powder (1%)
T_3 = Wheat Flour (82%), Semolina (2%), Oat Flour (2%), Barley Flour (2%), Corn Flour (2%), Ragi Flour (2%), Mung Bean (2%), Carrot Powder (2%), Guava Powder (2%)
T_4 = Wheat Flour (73%), Semolina (3%), Oat Flour (3%), Barley Flour (3%), Corn Flour (3%), Ragi Flour (3%), Mung Bean (3%), Carrot Powder (3%), Guava Powder (3%)
T_5 = Wheat Flour (64%), Semolina (4%), Oat Flour (4%), Barley Flour (4%), Corn Flour (4%), Ragi Flour (4%), Mung Bean (4%), Carrot Powder (4%), Guava Powder (4%)
T_6 = Wheat Flour (55%), Semolina (5%), Oat Flour (5%), Barley Flour (5%), Corn Flour (5%), Ragi Flour (5%), Mung Bean (5%), Carrot Powder (5%), Guava Powder (5%)
Fig. 1: Effect of functional properties on composite flour

Fig. 2: Effect of physico-chemical properties on composite flour
flour (0.790 g/cc). Bulk density of composite flour increased with increasing. Bulk density of the composite flours is also affected due to particles size and structure of individual flour.

**Physico-chemical properties of composite flours**

The moisture content of composite flours is ranged from 3.93 to 8.60% among all the flours. The highest moisture content was observed in T5 composite flour (8.60%) while lowest was in T1 wheat flour or control (3.93%). During the preparation of composite flour, the blending of flour to make composite flour observed the moisture from atmosphere condition due to their hygroscopicity properties.

The protein content of composite flours is ranged from 13.65 to 13.45% among all the flours. The highest protein content was observed in T1 wheat flour or control (13.65%) while lowest was in T5 composite (3.93%). Protein content of the sample is also affected due to nutritional composition of the individual flours. The protein content of composite flour decreased with decreasing.

The fat content of composite flours is ranged from 3.65 to 3.51% among all the flours. The highest fat content was observed in T1 wheat flour or control (3.65%) while lowest was in T5 composite (3.51%). Fat content of the sample is also affected due to moisture content and nutritional composition of the individual flours. The fat content of composite flour decreased with decreasing.

The crude fibre of composite flours is ranged from 4.35 to 4.56% among all the flours. The highest crude fibre was observed in T5 composite flour (4.56%) while lowest was in T5 composite (4.35%). Crude fibre of the sample is also affected due to moisture content and nutritional composition of the individual flours. The crude fibre of composite flour increased with increasing.

The ash content of composite flours is also affected due to atmospheric condition, moisture of the flour and ratio of individual flours and texture of flour.

The pH of composite flours is ranged from 6.81 to 5.77% among all the flours. The highest pH was observed in T1 wheat flour or control (6.81%) while lowest was in T5 composite (5.77%). The pH of the composite flours is also affected due ratio of individual flours and nutritional properties.

The carbohydrate of composite flours is ranged from 72.27 to 68.31% among all the flours. The highest carbohydrate was observed in T1 wheat flour or control (72.27%) while lowest was in T5 composite (68.31%). Carbohydrate of the sample is also affected due to moisture content and nutritional composition of the individual flours.

The energy of composite flours is ranged from 376.52 to 358.60 Kcal among all the flours. The highest energy was observed in T1 wheat flour or control (376.52 Kcal) while lowest was in T5 composite (358.60 Kcal). Energy of the sample is also affected due to nutritional properties of the individual flours.

The optical density of composite flours is ranged from 0.013 to 0.101 among all the flours. The highest optical density was observed in T5 composite flour (0.101) while lowest was in T1 wheat flour or control (0.013). Optical density of the sample is also affected due to nutritional composition of the individual flours. The optical density of composite flour increased with increasing.

**CONCLUSIONS**

In the recent research of functional and physicochemical properties of flours, swelling capacity, oil absorption capacity, foam capacity and foam stability decreased while the water absorption capacity, emulsion activity, emulsion stability and bulk density. Protein content of the sample is also affected due to nutritional composition of the individual flours. The protein content of composite flour decreased with decreasing. Crude fibre of the sample is also affected due to moisture content and nutritional composition of the individual flours. The crude fibre of composite flour increased with increasing. Oil absorption capacity of the composite flours is also affected due to moisture of the flour and ratio of individual flours, texture and particles size of the flour. Bulk density of the composite flours is also affected due to particles size and structure of individual flour. Emulsion stability of the composite flours is also affected due to protein content and carbohydrate of the individual flour. Foam capacity of the composite flours is also affected due to protein content and carbohydrate of the individual flour.

**REFERENCES**


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