**Introduction**

Mango (*Mangifera indica* L.) is one of the most important fruits worldwide, especially in Asia. Native to the Indian subcontinent and Southeast Asia, the mango is considered the king of fruits in India (Fowomola, 2010). A by-product of the pulping industry, mango peel is a waste product, but it is a good source of fiber, antioxidants, polyphenols, carotenoids, and more, so its use in any food product can help reduce waste issues. Considering nutritional value, mango peel contains 68.50, 2.05, 2.62, 5.40, and 26.5 percent water, protein, ash, fiber, and carbohydrates, respectively, providing 453.92 Kj per 100 g of energy (Bede et al., 2014). Eating fiber and phytochemicals such as polyphenols, carotenoids, tocopherols, and ascorbic acid can help improve health and protect against cancer, cardiovascular disease, and many other diseases. Inclusion of dietary fiber extends shelf life and alters the structural and physical properties of the product, such as texture, water and oil storage capacity, as well as viscosity and sensory properties (Figueroa et al., 2001). Hasan et al. (2011) reported that the physicochemical properties of fiber-rich mango skin powder make it a suitable alternative for the preparation of high-fiber foods such as baked goods. With this in mind, this study was conducted on the development of high fiber oat flour mixed biscuits using two types of mango skin powder. Different levels of Chausa and Langra with different amounts of oatmeal (34-42g) and his MPP (8-16g) substitutes. Chemical analysis was performed on raw mango peel, mango peel powder, wheat flour and oat flour. As a result, it was found that MPP contains a lot of ash, dietary fiber, and polyphenols. Compared to wheat flour samples, oat flour showed higher levels of protein, fat, ash and crude fiber. The processed products were stored at ambient conditions and subjected to chemical, microbiological and sensory evaluations at monthly intervals over 3 months. Treatment T1(50:34:16), with a lowest value of 1.74 mgGAE/g for treatment T1 (100:0:0). The highest scavenging activity of 33.14 percent was recorded with treatment T11(50:34:16), processing T1(100:0:0). However, increasing trends in water content and carbohydrates have been observed as storage evolves. Decreasing trends were observed for crude fiber, crude protein, crude fat, ash, total phenolics, and rinse activity. No bacterial counts were observed during the first few days. During 90 days of storage, treatment T4 (50:42:8) Treatment T1(100:0:0). Based on the sensory evaluation of the mixture, T5(50:40:10) received the highest ratings of 7.47 for taste, 7.51 for taste and 7.29 for overall acceptability. Storage studies have shown that all treatments have a shelf life of at least 90 days without compromising quality attributes. **Keywords**: Biscuits, oats, dietary fiber, mango peel powder

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**ABSTRACT**

In this study, high fiber oat flour mixed biscuits containing mango skin were prepared using two types of wheat flour, oat flour and mango skin powder. Chausa and Langra with different amounts of oatmeal (34-42g) and his MPP (8-16g) substitutes. Chemical analysis was performed on raw mango peel, mango peel powder, wheat flour and oat flour.

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**WASTE UTILIZATION OF MANGO PEEL AS POWDER INTO BISCUITS USING OAT AND WHEAT FLOUR**

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Material and Methods

Raw materials

Flour, oat flour and other ingredients were purchased from the local Jammu market. The hides were spread out on trays and dried in a forced air oven at 60-65°C for 18 hours to a moisture content of approximately 10%.

Development of biscuits

The biscuits were prepared from wheat flour, oat flour, and mango peel powder in varying proportions with other basic biscuit ingredients such as vegetable fat, sugar, baking powder, skimmed milk powder, glucose, sodium chloride, and water.

Mixing of Wheat flour + Oat flour+ MPP ↓
Creaming of sugar and fat ↓
Mixing of all the ingredients ↓
Kneading into Dough ↓
Rolling into sheets ↓
Cutting with a circular mould ↓
Baking at 205°C for 8-9 min ↓
Cooling at room temperature ↓
Packaging in pouches ↓
Storage of Biscuits

Physical parameters of biscuits

Diameter and thickness of biscuits were measured using vernier caliper. Spread ratio was calculated according to AACC method (1999) by dividing the average value of diameter by the average value of thickness of biscuits.

Chemical parameters

Moisture content

Moisture content was estimated according to (AOAC, 2002) and the weight difference was expressed as percent moisture content and calculated using the following formula:

\[
\text{Moisture content (\%)} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100
\]

Crude fiber

The crude fiber was estimated by AOAC, 2002 and was calculated as follows:

\[
\text{Crude fiber (\%)} = \frac{\text{Loss in weight on ignition (g)}}{\text{Weight of sample (g)}} \times 100
\]

Crude protein

Crude protein was estimated by micro-Kjeldahl method, using the factor 6.25 for converting nitrogen content into crude protein (Sadasivam and Manickam, 2008).

\[
\text{N(\%)} = \frac{\text{Titre value} \times 0.00014 \times \text{Volume made}}{\text{Aliquot taken (g)} \times \text{weight of sample (g)}} \times 100
\]

Crude Protein = N (%) x 6.25

Crude fat

The fat content was determined by (AOAC, 2002) and was calculated as below:

\[
\text{Crude fat (\%)} = \frac{\text{Weight of fat (g)}}{\text{Weight of sample (g)}} \times 100
\]

Ash

Ash was determined by AOAC, 2002. The per cent ash was calculated using the following formula:

\[
\text{Ash(\%)} = \frac{\text{Weight of ash (g)}}{\text{Weight of sample (g)}} \times 100
\]

Total phenolics

Total phenolic content of the extracts was determined colorimetrically, using the Folin-Ciocalteu method, as described by (Singleton et al., 1999).

\[
Y = 0.0158 + 0.0917X \quad r^2 = 0.99
\]

Scavenging Activity

The antioxidant activity was determined by DPPH (2,2,5,5-diphenyl-1-picrylhydrazyl) scavenging activity using DPPH as a free radical (Brand-Williams et al.,1995).

\[
\text{Scavenging activity (\%)} = \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \times 100
\]

Where, \(\text{Abs}_{\text{control}}\) = absorbance of control and \(\text{Abs}_{\text{sample}}\) = absorbance of sample

Microbial Count

Total plate count (TPC) was made as per the standard method (Ranganna, 2006) using nutrient agar medium. The results of total plate count (TPC) were expressed as log colony forming units (log cfu) of sample.

Sensory evaluation

The samples were evaluated on the basis of colour, texture/body, taste and overall acceptability by semi-trained panel of 9-10 judges using 9 point hedonic scale assigning scores 9- like extremely to 1-dislike extremely (Appendix-I). A score of 5.5 and above was regarded as acceptable (Amerine et al. 1965).

Statistical analysis

The results obtained were statistically analysed using completely randomized design (OP Stat software) for interpretation of results through analysis of variance (Gomez and Gomez, 1984).

Result and Discussion

Chemical Characteristics of raw materials:

The results on the chemical composition of oatmeal are comparable to those of Asif (2009). Compared to wheat flour samples, oat flour showed higher levels of protein, fat, ash and crude fiber. Wheat flour gave a higher moisture content. These approximate compositional results are comparable to those of Salehifar (2007). The total phenol content and scavenging activity of wheat and oat flour were reported to be 1.78, 6.01, 30.3 and 32.9, respectively. These observations are in good agreement with those of (Brindzova et al., 2008).
Physical parameters of biscuits

Diameter
The decrease in biscuit diameter may be due to substitution of oat flour with mango peel powder, and may be due to improper fermentation when baking high-fiber biscuits. This diameter reduction has also been reported by Nassar et al. (2007) and Pasha (2002) reported a significant decrease in diameter during storage for 60 days. Sujithra and Mahendran (2015) also reported that the decrease in diameter may be due to the carbohydrate contribution from oatmeal. Pasha et al. (2002) also reported that replacing sucrose with the food sweeteners fructose, sorbitol, and mannitol reduced the protein content of biscuits during 60 days of storage.

Thickness
Similar findings for thickness were made by his Khalil et al. (2015) Flour oat bran mixed biscuits and Nassar et al. (2008) also reported increased thickness of biscuits substituted with citrus by-products.

Spread rate
The results are largely consistent with Mishra and Chandra (2012) Rice bran and soy-enriched biscuits. Muridula et al. (2007) reported that increasing the proportion of sorghum flour in composite biscuits made from wheat and sorghum decreased the spread rate of the biscuits. The decrease in spread rate can be attributed to the decrease in dough firmness. Other researchers also reported reduced spread rates when wheat flour was replaced with soy and fenugreek flours (Hooda and Jood, 2005).

Chemical composition of Biscuits

Moisture
Moisture content of biscuits increased from 2.89 percent to 4.63 percent. Zhang et al. (1998) stated that the increased water absorption of wheat and oatmeal mixtures was due to the high β-glucan content of oats. These results were consistent with those of Desmond et al. match. (1998) they found that oat fiber helps retain moisture, resulting in juicier, lower-fat beef patties. Oat starch is more water absorbent than other cereals (Rossel, 2001). Nagi et al. (2012) also reported an increase in the moisture content of biscuits incorporated in cereal bran (wheat bran, rice bran, corn bran, barley bran, oat bran) during his 3-month storage. Aslam et al. (2014) observed that the moisture content increased during his 30-day storage of biscuits containing mango skin powder and mango seed powder.

Crude fiber
As reported by Dawkins et al. (1999) and Huang et al. (2011), the inclusion of oatmeal increases the crude fiber content in the product due to the higher insoluble fiber content in oats. An increasing trend in crude fiber content of biscuits made from cereal bran was also noted by Satinder et al. report. (2011). These results are consistent with the observations of Gernah et al. match. (2010) on increasing crude fiber content of biscuits made from flour mixtures by wheat brewers. The average crude fiber content decreased from the initial value of 4.69 percent to 4.34 percent during storage. A reduction in fiber content was also reported by Mridula and Gupta (2008) by including vajra flour in defatted soy flour-enriched biscuits. Pasha (2002) reported that replacing sucrose with the food sweeteners fructose, sorbitol, and mannitol during storage for 60 days reduced the crude fiber content of biscuits.

Crude protein
The reduction in protein content may be due to the Malayad reaction, which is the main cause of quality change and nutrient content decline in many foods. Nassar et al. (2008) reported a decrease in the protein content of biscuits replaced with citrus by-products. Olwam Komi et al. (2011) also reported a decrease in protein content with the addition of cassava flour. Baljeet et al. (2010) also reported that protein content decreased with increasing barley flour concentration. Carr et al. (2005) observed that crude protein and fat content decreased with increasing oatmeal content. This may be due to the carbohydrate contribution from oatmeal. Pasha et al. (2002) also reported that replacing sucrose with the food sweeteners fructose, sorbitol, and mannitol reduced the protein content of biscuits during 60 days of storage.

Crude Fat
Oomah (1983) reported that the improvement of weak wheat flour properties after the addition of oat products may be due to the high lipid content. Hood and Jood (2005) also reported that increasing the proportion of fenugreek flour in flour increased the fat content of biscuits. Shin et al. (2008) also reported that the crude fat content of biscuits spiked with varying amounts of jaggery decreased during storage. Sujithra and Mahendran (2015) also reported a decrease in fat content during storage of biscuits made from wheat defatted coconut flour. This decrease was due to the oxidation of unsaturated fatty acids due to absorption of atmospheric oxygen and moisture.

Ash
The increased ash content may be due to the higher ash content of the oatmeal and mango peel powders. Bertagnoli et al. (2014) reported an increase in ash content with increasing guava peel powder. Omeire and Ohambese (2010) observed an increasing trend in ash content (1.66-2.20%) in biscuits made from cashew nut flour with wheat fat. A significant decrease in ash content was observed with increasing storage time. Pasha et al. (2002) reported a decrease in ash content during storage of biscuits prepared with added dietary sweeteners.

Total phenolics
Due to the high total phenolic content of mango skin powder, the addition of mango skin powder increased the total phenolic content in high fiber biscuits. These results are also consistent with Ashoush and Gadallah (2011), who reported that total phenolic content increased with increasing levels of MPP and MKP incorporation. Bertagnoli et al. (2014) also reported that incorporating large amounts of guava peel powder into cookies resulted in a significant increase in phenolic compounds. A storage study showed that the phenolic content decreased during storage. Kim and Padilla-Zakour (2004) reported that the decrease in total phenols may be primarily due to oxidation, degradation of phenolic compounds, and polymerization of phenolic compounds with proteins. Oral et al. (2014) reported that all phenolic compounds in biscuits decreased during storage.
Scavenging activity

Ajila et al. (2008) also reported an increase in his DPPH scavenger activity with increasing MPP levels. Lady et al. (2005) found that the antioxidant activity of biscuits containing amla and raisin extracts decreased during storage. Valencia et al. (2007) used mango fiber concentrate in biscuits and bread and reported satisfactory shelf life. Nanditha et al. (2009) reported loss of antioxidant activity while preserving five natural antioxidants and their transport properties in biscuits.

Microbial analysis

Increased microbial counts may be due to increased moisture content during storage. After 3 months of storage, counts were minimal and within acceptable limits (Fawole et al., 2007). The microbial count results are consistent with Krishan and Aradhita (2007) in storage of biscuits enriched with mushroom powder. Nagi et al. (2012) also reported an increase in microbial counts after cereal bran biscuits were stored for 3 months.

Sensory evaluation

Colour

Incorporation above 10 percent was found to be relatively dark in color, presumably due to enzymatic browning. Aziah and Komathi (2009) also reported that mango peel powder imparts a dark brown color to crackers. This may have given the panelists the impression of overcooked product and influenced their preferences. A similar observation was made by Sudha et al. (2007) whose oat-incorporated biscuits were slightly darker. Reported have studied biscuits made by incorporating oat bran, but the use of barley bran has resulted in minor discrepancies. The darker color may be due to the non-enzymatic reaction (Maillard reaction) between the reducing sugar molecule and the lysine protein reported by Decker et al. (2002) was explained and Tsuji et al. (2001). Swapan and Rao (2016) also reported a decrease in colour score during 90 days of storage.

Texture

Results showed that the cookies had acceptable texture with up to 10 percent MPP compared to the control. As Ashoush and Gadallah (2011) reported, higher MPP substitution yields firmer biscuits due to higher water-holding capacity. The results obtained are also consistent with those of Smith (1972). Structural changes in biscuits are expected to occur during storage, as structural changes continue during static storage of processed foods, as reported by Brennan (2006). Swapan and Rao (2016) reported that the biscuits’ body and texture scores decreased from 0 days to 90 days with increasing storage time. Khalil et al. (2015) reported that average scores for biscuits decreased from 0 to 30 percent as oat bran substitution levels increased.

Flavour

The taste of the biscuits was improved by the addition of MPP as it had a typical mango flavor and a pleasant oat flavor. A similar reduction in flavor content was reported by his Ajila et al. report. (2008) is a biscuit that incorporates mango peel powder and Ashish and Gadallah (2011) is a biscuit that incorporates mango peel powder and mango seed powder. Loss of flavor during storage may be due to the volatility of flavor components or chemical interactions between different components. Chu et al. (2015) also reported that the flavour content decreased during 90 days of storage in low-fat biscuits containing polydextrose and guar gum.

Taste

Taste values increased by up to 10% with the introduction of MPP. However, when it exceeded 10%, a slightly bitter taste was produced. The taste results are largely consistent with those found by Ashish and Gadallah (2011) when 10 percent mango peel powder and 40 percent mango seed powder were incorporated into the biscuits. Similar results were reported by Hooda and Jood (2005), whose organoleptic results showed that incorporating up to 10% fenugreek wheat flour produced biscuits of acceptable quality and polypropylene without loss of change in their organoleptic properties. We have shown that the bag can be safely stored for up to 1 month.

Overall Acceptability

Nassar et al. (2008) also reported that 5 and 15 percent orange pulp and peel showed the highest receptivity for all sensory traits. Aziah and Komathi (2009) reported that the lowest concentration of mango peel crackers may be due to unattractive color and taste. Swapan and Rao (2016) reported that the overall acceptability rating of oatmeal cookies containing cheese showed a decreasing trend from the day 0 to day 90, but all were acceptable. Similar results were reported by his Stojceska et al. report. (2008) ready-to-eat grain-based expanded snack foods with cauliflower by-products.

Conclusion

Incorporating mango peel waste from the pulp industry into instant snack products such as cookies not only reduces pollution, but also helps develop fiber-rich cookies. Oatmeal is an excellent source of protein and fiber, so it can improve the nutritional composition of products under development.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>CMPP</th>
<th>LMPP</th>
<th>Wheat flour</th>
<th>Oat flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture (%)</td>
<td>6.98</td>
<td>6.23</td>
<td>10.80</td>
<td>7.41</td>
</tr>
<tr>
<td>2.</td>
<td>Crude Fiber (%)</td>
<td>8.71</td>
<td>7.76</td>
<td>1.29</td>
<td>4.27</td>
</tr>
<tr>
<td>3.</td>
<td>Crude Protein (%)</td>
<td>2.88</td>
<td>2.61</td>
<td>10.72</td>
<td>13.48</td>
</tr>
<tr>
<td>4.</td>
<td>Crude Fat (%)</td>
<td>2.31</td>
<td>2.20</td>
<td>1.18</td>
<td>5.87</td>
</tr>
<tr>
<td>5.</td>
<td>Carbohydrate (%)</td>
<td>86.59</td>
<td>87.94</td>
<td>75.17</td>
<td>70.51</td>
</tr>
<tr>
<td>6.</td>
<td>Ash (%)</td>
<td>3.26</td>
<td>3.02</td>
<td>1.46</td>
<td>1.73</td>
</tr>
<tr>
<td>7.</td>
<td>Total phenolics (mg GAE/g)</td>
<td>64.6</td>
<td>60.4</td>
<td>1.78</td>
<td>6.01</td>
</tr>
<tr>
<td>8.</td>
<td>Scavenging activity (%)</td>
<td>53.30</td>
<td>45.6</td>
<td>30.3</td>
<td>32.9</td>
</tr>
</tbody>
</table>
Table 2: Physical parameters of fiber rich biscuits

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Diameter (mm)</th>
<th>Thickness (mm)</th>
<th>Spread Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁ (100:0:0::WF:OF:MPP)</td>
<td>55.0</td>
<td>6.30</td>
<td>8.73</td>
</tr>
<tr>
<td>T₂ (0:100:0::WF:OF:MPP)</td>
<td>56.5</td>
<td>6.50</td>
<td>8.69</td>
</tr>
<tr>
<td>T₃ (50:42:8::WF:OF:CMPP)</td>
<td>56.0</td>
<td>6.40</td>
<td>8.75</td>
</tr>
<tr>
<td>T₄ (50:42:8::WF:OF:LMPP)</td>
<td>55.5</td>
<td>6.35</td>
<td>8.74</td>
</tr>
<tr>
<td>T₅ (50:40:10::WF:OF:CMPP)</td>
<td>55.0</td>
<td>6.50</td>
<td>8.46</td>
</tr>
<tr>
<td>T₆ (50:40:10::WF:OF:LMPP)</td>
<td>54.0</td>
<td>6.45</td>
<td>8.37</td>
</tr>
<tr>
<td>T₇ (50:38:12::WF:OF:CMPP)</td>
<td>52.5</td>
<td>6.65</td>
<td>7.89</td>
</tr>
<tr>
<td>T₈ (50:38:12::WF:OF:LMPP)</td>
<td>52.0</td>
<td>6.60</td>
<td>7.88</td>
</tr>
<tr>
<td>T₉ (50:36:14::WF:OF:CMPP)</td>
<td>51.5</td>
<td>6.85</td>
<td>7.52</td>
</tr>
<tr>
<td>T₁₀ (50:36:14::WF:OF:LMPP)</td>
<td>51.0</td>
<td>6.75</td>
<td>7.56</td>
</tr>
<tr>
<td>T₁₁ (50:34:16::WF:OF:CMPP)</td>
<td>50.5</td>
<td>7.00</td>
<td>7.21</td>
</tr>
<tr>
<td>T₁₂ (50:34:16::WF:OF:LMPP)</td>
<td>50.0</td>
<td>6.95</td>
<td>7.19</td>
</tr>
</tbody>
</table>

Table 3: Effect of treatments and storage on proximate composition of biscuits

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean values of Storage (0-90 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture</td>
</tr>
<tr>
<td>T₁ (100:0:0::WF:OF:MPP)</td>
<td>2.89</td>
</tr>
<tr>
<td>T₂ (0:100:0::WF:OF:MPP)</td>
<td>3.32</td>
</tr>
<tr>
<td>T₃ (50:42:8::WF:OF:CMPP)</td>
<td>3.83</td>
</tr>
<tr>
<td>T₄ (50:42:8::WF:OF:LMPP)</td>
<td>3.69</td>
</tr>
<tr>
<td>T₅ (50:40:10::WF:OF:CMPP)</td>
<td>4.12</td>
</tr>
<tr>
<td>T₇ (50:38:12::WF:OF:CMPP)</td>
<td>4.24</td>
</tr>
<tr>
<td>T₈ (50:38:12::WF:OF:LMPP)</td>
<td>4.19</td>
</tr>
<tr>
<td>T₉ (50:36:14::WF:OF:CMPP)</td>
<td>4.47</td>
</tr>
<tr>
<td>T₁₀ (50:36:14::WF:OF:LMPP)</td>
<td>4.41</td>
</tr>
<tr>
<td>T₁₁ (50:34:16::WF:OF:CMPP)</td>
<td>4.75</td>
</tr>
<tr>
<td>T₁₂ (50:34:16::WF:OF:LMPP)</td>
<td>4.63</td>
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</table>

Table 4: Effect of treatments and storage on Sensory scores of biscuits

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean values of Storage (0-90days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Colour</td>
</tr>
<tr>
<td>T₁ (100:0:0::WF:OF:MPP)</td>
<td>7.97</td>
</tr>
<tr>
<td>T₂ (0:100:0::WF:OF:MPP)</td>
<td>7.41</td>
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<tr>
<td>T₃ (50:42:8::WF:OF:CMPP)</td>
<td>7.80</td>
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<tr>
<td>T₄ (50:42:8::WF:OF:LMPP)</td>
<td>7.74</td>
</tr>
<tr>
<td>T₅ (50:40:10::WF:OF:CMPP)</td>
<td>7.64</td>
</tr>
<tr>
<td>T₆ (50:40:10::WF:OF:LMPP)</td>
<td>7.59</td>
</tr>
<tr>
<td>T₇ (50:38:12::WF:OF:CMPP)</td>
<td>7.36</td>
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<tr>
<td>T₈ (50:38:12::WF:OF:LMPP)</td>
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<td>T₉ (50:36:14::WF:OF:CMPP)</td>
<td>6.95</td>
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<td>T₁₀ (50:36:14::WF:OF:LMPP)</td>
<td>6.89</td>
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<tr>
<td>T₁₁ (50:34:16::WF:OF:CMPP)</td>
<td>6.73</td>
</tr>
<tr>
<td>T₁₂ (50:34:16::WF:OF:LMPP)</td>
<td>6.67</td>
</tr>
</tbody>
</table>
Fig. 1: Mean values of treatment and storage of Total phenols and scavenging activity

Fig. 2: Effect of Microbial count (x10^2 cfu/g) on biscuits
Ankita Choudhary

Plate 1: Different ingredients of biscuit

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