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

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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. 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 T11(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

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 2010). 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 (Figuerola *et al*., 2005).

Oats (*Avena sativa* L.) ranks sixth in global cereal production statistics, behind wheat, corn, rice, barley and sorghum. Oat consumption is gradually increasing, and the main health benefits of oats depend on their fiber and β-glucan content (Ahmad *et al*., 2014). Approximate composition of oats per 100 g: 66 g carbohydrates, 11 g fiber, 7 g fat, 17 g protein, 1.3 mg pantothenic acid (B5), 5 mg iron, 177 g magnesium, 54 g beta-glucan becomes. Additionally, oats are a rich source of amino acids, B vitamins and many minerals (Marquart and Coben, 2005). The main use of oats in food is for grinding into oatmeal or fine oatmeal. Oatmeal can be eaten as porridge, but it can also be eaten raw as cookies.

Wheat (*Triticum aestivium* L.) is a major protein source in the daily diet (Wahab *et al*., 2014). The nutritional content of wheat flour contains 12.0g moisture, 10.0g protein, 1.6g fat, 72.6g carbohydrates, 1.3g dietary fiber, and 1.4g ash per 100g. In recent years, as nutritional value has increased, interest in baked goods has increased due to their fiber content (Gomez *et al*., 2010). Cookies are the most commonly consumed. Its popularity is due to its ready-to-eat nature, excellent nutritional value, ready availability, diverse flavors and long shelf life (Gandhi *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 are combined to enhance the nutritional properties of the developed product.

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).

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

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 (Singelton *et al.*, 1999).

$$Y = 0.0158 + 0.0917X \qquad r^2 = 0.99$$

Scavenging Activity

The antioxidant activity was determined by DPPH (2,2,-diphenyl-1-picryihydrazyl) 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, $\text{Abs}_{\text{contol}}$ = 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*. reported (2008) Biscuits with orange peel, and Sudha *et al*. (2007) biscuit enriched with wheat, rice, oat and barley bran

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. Sujirtha and Mahendran (2015) also reported that the protein content of biscuits made from wheat defatted coconut flour decreased significantly during 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. Sujirtha 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 Ohambele (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) he 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). Swapna 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). Swapna 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. Swapna 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 1 : Physico-chemical composition of raw materials

S.No.	Parameters	CMPP	LMPP	Wheat flour	Oat flour
1.	Moisture (%)	6.98	6.23	10.80	7.41
2.	Crude Fiber (%)	8.71	7.76	1.29	4.27
3.	Crude Protein (%)	2.88	2.61	10.72	13.48
4.	Crude Fat (%)	2.31	2.20	1.13	5.87
5.	Carbohydrate (%)	86.59	87.94	75.17	70.51
6.	Ash (%)	3.26	3.02	1.46	1.73
7.	Total phenolics (mg GAE/g)	64.6	60.4	1.78	6.01
8.	Scavenging activity (%)	53.30	45.6	30.3	32.9

Table 2 : Physical parameters of fiber rich biscuits

Treatments	Diameter (mm)	Thickness (mm)	Spread Ratio
T_1 (100:0:0::WF:OF:MPP)	55.0	6.30	8.73
T_2 (0:100:0::WF:OF:MPP)	56.5	6.50	8.69
T_3 (50:42:8::WF:OF:CMPP)	56.0	6.40	8.75
T_4 (50:42:8::WF:OF:LMPP)	55.5	6.35	8.74
T_5(50:40:10::WF:OF:CMPP)	55.0	6.50	8.46
T_6(50:40:10::WF:OF:LMPP)	54.0	6.45	8.37
T_7(50:38:12::WF:OF:CMPP)	52.5	6.65	7.89
T_8(50:38:12::WF:OF:LMPP)	52.0	6.60	7.88
T_9(50:36:14::WF:OF:CMPP)	51.5	6.85	7.52
T_{10}(50:36:14::WF:OF:LMPP)	51.0	6.75	7.56
T_{11}(50:34:16::WF:OF:CMPP)	50.5	7.00	7.21
T_{12}(50:34:16::WF:OF:LMPP)	50.0	6.95	7.19

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

Treatment	Mean values of Storage (0-90 days)				
	Moisture	Crude fiber	Crude protein	Crude fat	Ash
T_1 (100:0:0::WF:OF:MPP)	2.89	2.49	6.99	20.63	1.18
T_2 (0:100:0::WF:OF:MPP)	3.32	4.43	8.69	21.23	2.33
T_3 (50:42:8::WF:OF:CMPP)	3.83	4.66	7.28	21.31	1.67
T_4 (50:42:8::WF:OF:LMPP)	3.69	4.54	7.25	21.24	1.49
T_5(50:40:10::WF:OF:CMPP)	4.12	4.74	7.18	21.50	1.71
T_6(50:40:10::WF:OF:LMPP)	3.96	4.62	7.14	21.45	1.53
T_7(50:38:12::WF:OF:CMPP)	4.24	4.81	7.05	21.67	1.74
T_8(50:38:12::WF:OF:LMPP)	4.19	4.70	7.02	21.60	1.57
T_9(50:36:14::WF:OF:CMPP)	4.47	4.86	6.95	21.82	1.78
T_{10}(50:36:14::WF:OF:LMPP)	4.41	4.78	6.92	21.76	1.61
T_{11}(50:34:16::WF:OF:CMPP)	4.75	4.92	6.77	22.71	1.82
T_{12}(50:34:16::WF:OF:LMPP)	4.63	4.87	6.74	22.65	1.65

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

Treatment	Mean values of Storage (0-90days)				
	Colour	Texture	Flavour	Taste	Overall
T_1 (100:0:0::WF:OF:MPP)	7.97	7.87	7.89	7.89	7.87
T_2 (0:100:0::WF:OF:MPP)	7.41	7.26	7.38	7.49	7.38
T_3 (50:42:8::WF:OF:CMPP)	7.80	7.21	7.61	7.60	7.55
T_4 (50:42:8::WF:OF:LMPP)	7.74	7.17	7.54	7.50	7.48
T_5(50:40:10::WF:OF:CMPP)	7.64	7.09	7.80	7.80	7.58*
T_6(50:40:10::WF:OF:LMPP)	7.59	7.03	7.71	7.71	7.50
T_7(50:38:12::WF:OF:CMPP)	7.36	6.95	7.48	7.43	7.30
T_8(50:38:12::WF:OF:LMPP)	7.30	6.88	7.44	7.37	7.23
T_9(50:36:14::WF:OF:CMPP)	6.95	6.64	7.38	7.12	7.03
T_{10}(50:36:14::WF:OF:LMPP)	6.89	6.60	7.33	7.07	6.96
T_{11}(50:34:16::WF:OF:CMPP)	6.73	6.38	7.08	6.83	6.76
T_{12}(50:34:16::WF:OF:LMPP)	6.67	6.34	7.03	6.75	6.70

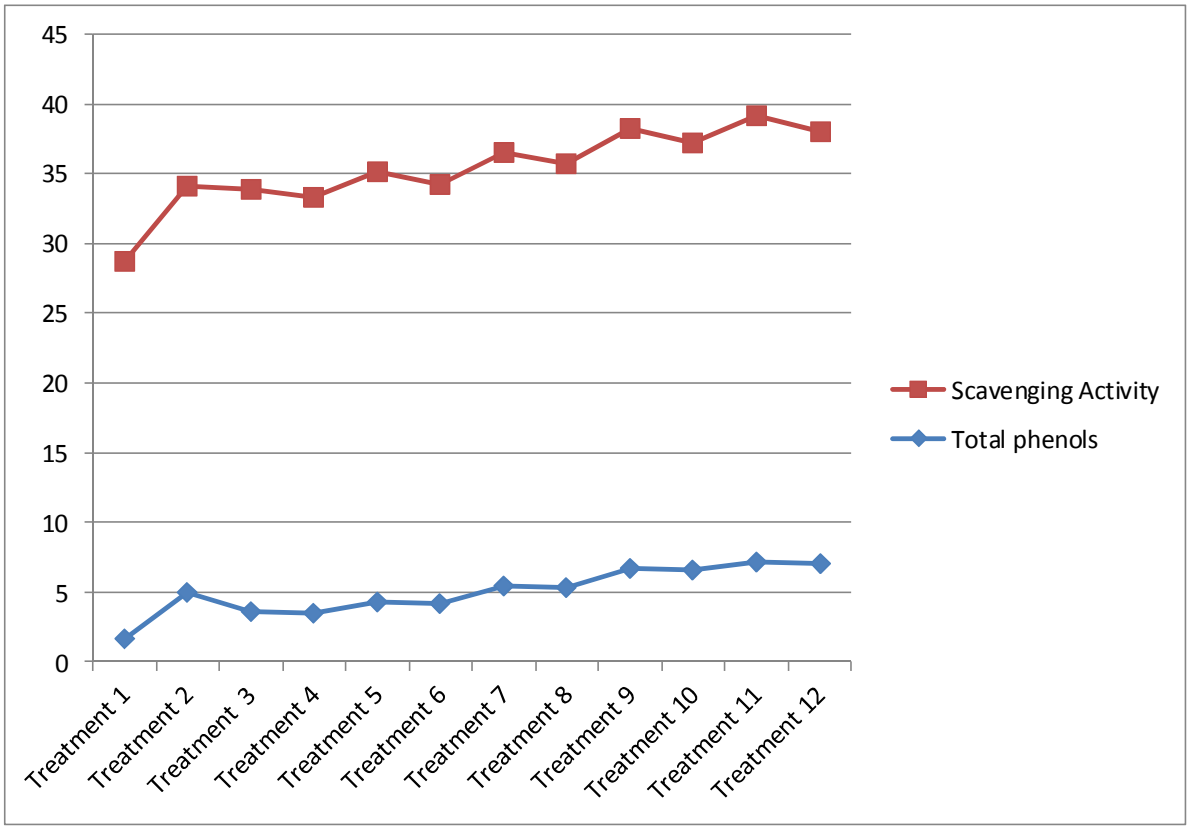

Fig. 1 : Mean values of treatment and storage of Total phenols and scavenging activity

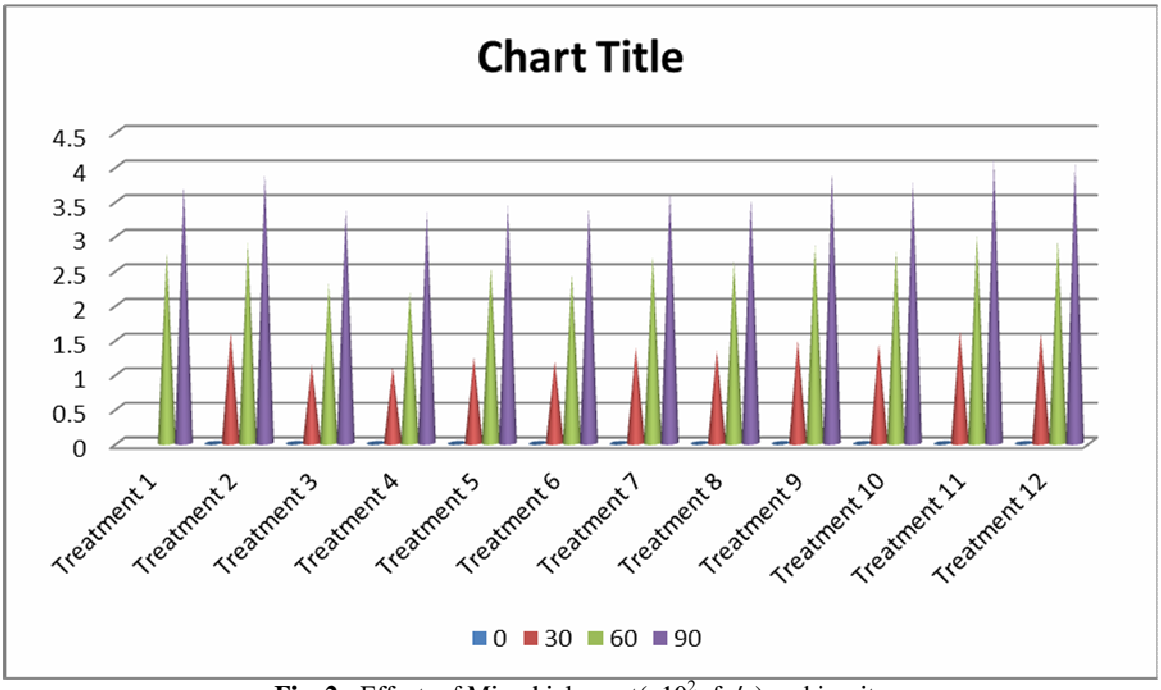

Fig. 2 : Effect of Microbial count($x10^2$ cfu/g) on biscuits

Plate 1: Different ingredients of biscuit

References

AACC (1999). Approved methods of the American Association of cereal Chemists.10th ed. American Association of Cereal Chemists, St.Paul,Minnesota

Ahmad, M., Gul-Zaffar, Z.A. and Habib, M. (2014). A review on oat (*Avena sativa* L.) as a dual-purpose crop. *Scientific Research and Essays*, 9(4): 52-59.

Ajila, C.M., Leelavathi, K. and Prasada Rao, U.J.S. (2008). Improvement of dietary fibre content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *Journal of Cereal Science*, 48: 319-326.

Amerine, M.A., Pangborn, R.H. and Roseller, E.B. (1965). *Principles of Sensory Evaluation of Food,* 23-45, Academic Press, New York

AOAC, (2002). Official methods of analysis. 16th ed., Association of Official Analytical Chemists, Washington, D.C.

Ashoush, I.S. and Gadallah, M.G.E. (2011). Utilization of mango peels and seed kernels powders as source of phytochemicals in biscuit. *World Journal of Dairy and Food Sciences*, 6 (1): 35-42.

Asif, A., Anjum, F.A., Zahoor, T. and Nawaz, H. (2009). Extraction of ßglucan from oat and its interaction with

glucose and lipoprotein profile. *Pakistan Journal of Nutrition,* 8:1486-1492.

Aslam, H.K.W., Raheem, M.I., Ramzan, R., Shakeel, A., Shoaib, M. and Sakandar, H.A. (2014). Utilization of mango waste material (peel, kernel) to enhance dietary fiber content and antioxidant properties of biscuit. *Journal of Global Innovations in Agricultural and Social Sciences*, 2(2) : 76-81.

Aziah, N.A.A. and Komathi, C.A. (2009). Acceptability attributes of crackers made from different types of composite flour. *International Food Research Journal*, 16: 479-482.

Baljeet, S.Y., Ritika, B.Y. and Roshan, L.Y. (2010). Studies on functional properties and incorporation of buckwheat flour for biscuit making. *International Food Research Journal,* 17: 1067-1076.

Bede, N.O. (2010). Nutritional implication of projects giving high priority to the production of staples of low nutritive quality: The case for Cassava (Manihot esculenta, Crantz) in the humid tropics of West Africa. *International Institute of Tropical Agriculture, Ibadan, Nigeria*

Bertagnolli, S.M.M., Silveira, M.L.R., Fogaca, A.O., Umann, L. and Penna, N.G. (2014). Bioactive compounds and acceptance of cookies made with guava peel flour. *Journal of Food Science and Technology*, 34(2): 303-308.

Brand-Williams, W., Cuvelier, M.E. and Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT-Food Science and Technology*, 28(1):25-30.

Brennan, J.G. (2006). Food processing handbook. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim Brindzova, L., Certik, M., Rapta, P., Zalibera, M., Mikulajova, A. and Takacsova M. (2008). Antioxidant activity, β-glucan and lipid contents of oat varieties. *Czech Journal of Food Science*, 26: 163–173.

Chugh, B., Singh, G. and Kumbhar, B.K. (2016). Optimization of Ingredients for Development of Low-Fat Biscuits Using Response Surface Methodology. *Journal of Food and Industrial Microbiology*, 2(1): 110.

Dawkins, N.L., Phelps, O., McMillin, K.W and Forrester, I.T. (1999). Composition and physico-chemical properties of chevon patties containing oat bran. *Journal of Food Science,* 64: 597-600.

Decker, E., Beecher, G., Slavin, J., Miller, H.E. and Marquart, L. (2002). Whole grains as a source of antioxidants. *Cereal Foods World*, 47(8): 370-373.

Desmond, E., Troy, D., and Buckley, D. (1998). The effects of tapioca starch, oat fibre and whey protein on the physical and sensory properties of low-fat beef burgers. *Lebensmittel Wissenschaft und Technologie*, 31: 653-657.

Fawole, O.O., Ogundiran, M.A., Ayandiran, T.A. and Olagunju, O.F. (2007). Proximate mineral Composition in some selected fresh water fishes in Nigeria. *Journal of Food Safety*, 9: 52-55.

Figuerola, F., Hurtado, M.L., Estevez, A.M., Chiffelle, I. and Asenjo, F. (2005). Fiber concentrates from apple pomace and citrus peel as potential fiber sources for food enrichment. *Food Chemistry*, 91: 395-401.

Fowomola, M.A. (2010). Some nutrients and antinutrients contents of mango (Mangifera indica) seed. *African Journal of Food Science,* 4(8):472-476.

Gandhi, A.P., Kotawaliwale, N., Kawalkar, J., Srivastava, D.C., Parihar, V.S and Raghunandan, P. (2001). Effect of incorporation of defatted soy flour on the quality of sweet biscuits. *Journal of Food Science and* Technology, 38: 502-503.

Gernah, D.I., Senger, I.A. and Audu, J.O. (2010). Physico-chemical and sensory evaluation of cookies produced from wheat and brewers spent grain composite flour. *Nigerian Food Journal*, 28: 440–447.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research (2nd Ed.) A Wiley–Interscience Publication, John Wiley and Sons, New York : 680.

Gomez, M., Moraleja, A., Oliete, B., Ruiz, E. and Caballero, P.A. (2010). Effect of fibre size on the quality of fibre enriched layer cakes. *LWT-Food Science and Technology*, 43:33-38.

Hassan, F.A.A., Ismail, A., Abdul, H.A., Azlan, S. and Al-Sheraji, H. (2011). Characterization of fiber-rich powder and antioxidant capacity of *Mangifera pajang* K. fruit peels. *Food Chemistry,* 126:283-288.

Hooda, S. and Jood, S. (2005). Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. *Food Chemistry,* 90 (3): 427-435.

Kerr, W.L., Wang, X. and Choi, S.G. (2005). Physical and sensory characteristics of low-fat Italian sausage prepared with hydrated oat. *Journal of Food Quality*, 28(1): 62-77.

Khalil, A.W., Ali, J., Masood, T., Arif. M., Parvez, M. and Hassan, S. (2015). Effect of oat bran on the quality of enriched high fiber biscuits. *World Journal of Dairy and Food Sciences*, 10 (1): 68-73.

Kim, D.O. and Padilla-Zakour, O.I. (2004). Jam processing effect on phenolics and antioxidant capacity in anthocyanin-rich fruits: cherry, plum and raspberry. *Journal of Food Science*, 69:395-400.

Krishnan, K. and Aradhita, B. (2007). Nutritional evaluation and storage studies of button mushroom powder fortified biscuits. *Mushroom Research-an International Journal of Mushroom,* 16(1):31-35.

Marquart, L. and Coben, E.N. (2005). Increasing whole grain consumption. *International Journal of Agriculture Sciences,* 59: 24-33.

Mishra, N. and Chandra, R. (2012). Development of functional biscuits from soy flour and rice bran. *International Journal of Agricultural and Food Science*, 2(1): 14-20.

Mridula, D. and Gupta, R.K. (2008). Effect of bajra flour on quality of biscuits fortified with defatted soy flour. *The Indian Journal of Nutrition and Dietetics,* 45: 17-25.

Nagi, H.P.S., Kaur, J., Dar, B.N. and Sharma S. (2012). Effect of storage period and packaging on the shelf life of cereal bran incorporated biscuits. *American Journal of Food Technology*, 7(5): 301-310.

Nanditha, B.R., Jena, B.S., Prabhashankar, P. (2009). Influence of natural antioxidants and their carry-through property in biscuit processing. *Journal of the Science of Food and Agriculture*, 89: 288–298

Nassar, A.G., AbdEl-Hamied, A.A. and El-Naggar, E.A. (2008). Effect of citrus by-products flour incorporation on chemical, rheological and organoleptic characteristics of biscuits. *World Journal of Agricultural Sciences,* 4(5): 612-616.

Oluwamukomi, M.O., Oluwalana, I.B. and Akinbowale, O.F. (2011). Physicochemical and sensory properties of wheat cassava composite biscuit enriched with soy flour. *African Journal of Food Science*, 5(2): 50-56.

Omeire, G.C. and Ohambele, F.I. (2010). Production and evaluation of biscuits from composite wheat/deffated cashew nut flours. *Nigerian Food Journal,* 28: 401–406.

Oomah, B.D. (1983). Baking and related properties of wheat-oat composite flours. *Cereal Chemistry,* 60(3):220-225.

Oral, R.A., Dogan, M. and Sarioglu, K. (2014). Effect of certain polyphenols and extracts on furans and acrylamide formation in model system and total furans during storage. *Food Chemistry*, 142: 423-9.

Ranganna, S. (2006). Manual analysis of fruit and vegetable products. Tata Mc Graw-Hill, New India, India.

Reddy, V., Urooj, A. and Kumar, A. (2005). Evaluation of antioxidant activity of some plant extracts for their application in biscuits. *Food Chem*istry, 90: 317-321.

Rosell, C.M. and Gomez, M. (2001). Freezing in bread making performance: frozen dough and part- baked bread. *Food Reviews International*, 23:303-319.

Sadasivam, S. and Manickam, A. (2008). *Biochemical methods*, New Age International (P) Ltd, New Delhi, India.

Salehifar, M. and Shahedi, M. (2007). Effects of oat flour on dough rheology, texture and organoleptic properties of taftoon bread. *Journal of the Science of Food and Agriculture*, 9: 227-234.

Satinder, K., Sativa, S. and Nagi, H.P.S. (2011). Functional properties and anti-nutritional factors in cereal bran. *Asian Journal of Food and Agro-Industry*, 4:122–131.

Singh, U., Kumar, J. and Jaipal, M.K. (2008). Manufacture of biscuits using various levels of jaggery as additives. *Beverage Food World*, 21:58-59.

Singleton, V.L., Orthofer, R. and LamuelaRaventos, R.M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology*, 299: 152-178.

Smith, W.H., (1972). Hard semi-sweet biscuits. In: biscuits, crackers and cookies: Technology, Production and Management, *Applied Science Publishers Ltd*., *London*, 1: 466-473.

Stojceska, V., Ainsworth, P., Plunkett, A., Ibanoglu, E. and Ibanoglu, S. (2008). Cauliflower by-product as a new source of dietary fibre, antioxidants and proteins in cereal based ready-to-eat expanded snacks. *Journal of Food Engineering*, 87: 554-563.

Sudha, M.L., Vetrimani, R. and Leelavathi, K. (2007). Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. *Food Chemistry,* 100: 1365-1370.

Sujirtha, N. and Mahendran, T. (2015). Influence of storage conditions on the quality characteristics of wheat-defatted coconut flour biscuits packed in metalized polypropylene. *International Journal of Engineering Research & Technology*, 4(7): 948-950.

Swapna, K.S. and Rao, K.J. (2016). Studies on effect of oat and cheese incorporation on sensory and textural quality of short-dough type biscuit. *Journal of Food Science and Technology*, 53(3): 1505–1514

Tsuji, H., Kimoto, M. and Natori, Y. (2001). Allergens in major crops. *Nutrition Research*, 21: 925-934.

Valencia, N.V., Granados-Perez, E., Agama-Acevedo, E., Tovar, J., Ruales, J., Bello-Perez, L. A. 2007. Fibre concentrate from mango fruit: Characterization, associated antioxidant capacity and application as a bakery product ingredients. *LWT—Food Science and Technology*, 40: 722-729.

Wahab, S., Khattak, M.K., Khalil, S.K. and Ullah, F. (2014). Effect of cowpea flour supplementation on the nutritive value of whole wheat flour leavened bread. *World Journal of Pharmaceutical Research*, 3:4393- 4403.

Zhang, D., Moore, W.R., Doehlert, D.C. (1998). Effects of oat grain hydrothermal treatments on wheat-oat flour dough properties and bread baking quality. *Cereal Chemistry*, 75: 602-605.