International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Nutritional and organoleptic properties of gluten free biscuits prepared from foxtail millet (*Setaria italica*) and wheat flour composites

Ritu Rani*, Manju Nehra, Brij Lal Karwasra, Anil Kumar Siroha

Department of Food Science and Technology, Chaudhary Devi Lal University, Sirsa (Hr),India

*Corresponding author: Ritu Rani, Department of Food Science and Technology,

Chaudhary Devi Lal University, Sirsa, Haryana-125055, India.

Abstract:

Incorporation of foxtail millet flour in wheat flour for biscuit preparation was observed. After addition of foxtail millet flour fat, protein and fiber content of composite flour was increased upto 2.1, 2.6 and 12.60%, respectively in flour composite of 40% foxtail millet. Significant differences ($p<0.05$) were observed for functional properties of composite flour as compared to the wheat flour. PV, BV, TV and FV decreased with increase in percentage of foxtail millet flour in composite flour and reached upto 290, 79, 211, and 620 cP, respectively. It was observed that diameter and spread ratio decreased whereas thickness and weigh of biscuits was increased as compared to control sample. It was observed that ash, fat, protein and fibre content was increased as compared to control biscuit. The hedonic test showed a pleasant appreciation for all the biscuits except 40% composition biscuits. Sample containing more than 20% were poorly scored as compared to the control.

Key words:
Foxtail millet, pasting properties, gluten free biscuit.

1. Introduction

Foxtail millet (*Setaria italica*), of one of the earliest cultivated cereal crops belong to family *Poaceae*, has been grown in China for over 7000 years (Sharma & Niranjan, 2018) and is now widely planted in India, Nigeria, the United States, and other countries (Lata *et al*., 2013). Foxtail millet is also called as Kangani in India. Foxtail millet is called bydifferent names in different languages like; Kakum (Hindi), Rala (Marathi), Thinai (Tamil), Korra (Telugu), Navane (Kannada), Kangani (Punjabi), Kanghu, Kangam, Kora (Oriya), Kang (Gujarati), Kaon (Bengali) (Mlam *et al*., 1971). In India, millet is said to be fourth mostcommon grown cereal after rice, wheat and sorghum. The color of foxtail millet kernel varies over a wide range from almost pale yellow to orange, red, brown or black in color. India is leading producer (1,15,60,000 tonnes) followed by Niger (37,90,028 tonnes) of millets (FAO, 2017) and its cultivation is next to rice and wheat. Major Foxtail millet growing area Karnataka, Tamil Nadu, Andhra Pradesh, Punjab, Haryana, Rajasthan, Maharashtra, Arunachal Pradesh (ICAR, 2005-06).

Foxtail millet contains 12.3% protein, 60.9% carbohydrates, 4.3% fat, 8.0% crude fiber, and 3.3% mineral matter (Muthamilarasan *et al*., 2016). Protein content is higher than major cereals. Foxtail millet have protein content is (12.3g/100g) comparable with rice (6.8g/100g), wheat (11.8g/100g) (Amadou *et al.*, 2011). Foxtail millet contains other nutrients like fat, crude fiber, amylose, amylopectin and vitamins. The essential amino acid profile shows more leucine, isoleucine, valine, phenyl alanine, arginine, histidine and lysine in foxtail millet protein than proteins of sorgum and other millet (NIN, 2007). Besides being rich in potassium, sulphur, calcium, magnesium and high level of linoleic acid (Gopalan *et al*., 2007). Foxtail millet has anti-proliferative, anti-diabetic and cholesterol lowering activities (Park *et al.*, 2008). These activity are attributed to presence of polyphenols for instance, chlorogenic acid, coumeric acid are involved in scavenging free radicals, regulating oxidative stress levels, inhibiting α-glucosidase enzyme activity and altering adiponectin concentration in the body (Chandrasekara & Shahidi, 2011).

The concepts of food consumption are changing from previous to present time. Previous emphasis has been on survival, hunger satisfaction, health maintenance and absence of adverse effects on health and current emphasis is on encouraging the use of nutraceutical foods which promise to promote better health and well being thus helping to reduce the risk of chronic diseases such as obesity, diabetes, cardiovascular disease and cancer (Anju *et al*., 2010). Foxtail millet has been recognised as potential functional food to promote a state of better health and to help reduce the risk of diseases (Anand *et al*., 2008). The health benefits attributed in part to antioxidants, including a variety of vitamins, minerals, and phytochemicals, that deactivate free radicals and thereby prevent damage to cellular membranes or genetic material within the cell (Mutaugh *et al.*, 2004; Zia-Ul-Haq *et al.*, 2014). There is a decline in consumption of millets and its products, where in it is originated and grown is due to the shift in consumer habits, rapid rate of urbanization, time and energy required to prepare millet based foods, inadequate domestic structure, poor marketing facilities, processing techniques, unstaple supplies and relative unavailability of millets (Balasubramanian, 2013). Wheat is considered unique among cereals for its consumption in the form of various types of baked goods in different countries of the world (Khatkar and Schofield, 1997). The quality and diversity of products manufactured from wheat are remarkable.The gluten is a protein complex found in the triticeae tribe of wheat, barley (*Hordeum vulgare*) and rye (*Secalecereale*), which provides desirable organoleptic properties (texture and taste) to many bakery and other food products. Gluten is known as "heart and soul" of bakery for providing the processing qualities familiar to both the home baker as well as the commercial food manufacturer. Since gluten plays a limited role in defining the processability and end product quality of bakery products, it can be complemented through some alternate flours in various combinations (Rai *et al.*, 2014).

Biscuits are the most popular bakery items consumed by nearly everyone. This is mainly due to their ready to eat nature, good nutritional quality, availabilityin numerous varieties, and affordability. Based onproduction statistics, the top three producers ofbiscuits are the United States, China, and India, respectively (Misra & Tiwari, 2014). Amongst the ready to eat products, biscuits are of significant importance because they arewidely accepted, affordable and they have a relatively long shelf-life (Florence-Suma *et al.*, 2012). Due to large diffusion, biscuits have also been frequently considered as a vehicle for healthy substances having antioxidant or prebiotic properties (Ajila *et al.*, 2015). Limited informationwas available on the formulation of bakery products from foxtail millet. So, present study was conducted to study the effect of partial replacement of wheat flour with foxtail millet flour on nutritional, textural and sensorial properties of biscuits.

2. Material and methods

2.1 Materials

Foxtail millet and wheat grain were purchased from local market Sirsa, Haryana (India). The foxtail millet and wheat grains were cleaned. After that they were milled and then flour was prepared. All the chemicals and materials were used of analytical grade

2.2 Proximate composition and Functional properties

Foxtail millet flour and Wheat flour were analysed for their chemical compositions as follows:

Moisture (925.10), protein (984.13), fat (920.85), ash (923.03) and crude fiber (962.09) contents of Wheat and Foxtail Millet cultivars were determined according to standard methods of AOAC on dry weight basis (dwb).

Total carbohydrates content was determined by subtraction method.

Swelling power and solubility were determined with the procedure proposed by Leach et al.. Water absorption capacity and water solubility index were determined by following theprocedure as described by Sosulski, 1976.

Oil absorption capacity was determined following the procedure described by Lin et al.,1974.

Emulsion activity (EA): The emulsion activity of sample was determined by method of Yasumatsu et al. (1972). The emulsion (1 g sample, 10 mL distilled water and 10 mL soybean oil) was prepared in calibrated centrifuge tube at 2000 × g for 5 min. The ratio of theheight of emulsion layer to the total height of the mixture was calculated as emulsion activity in percentage.

Foaming capacity: The foam capacity (FC) of flour were determined as described by (Narayana & Narsinga Rao, 1982) with slight modification. The 1 g flour sample was added to 50 mL distilled water at 30 ± 2 °C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam was recorded 30 s after whipping to determinefoam capacity as present of the initial foam volume.

Foam capacity (%) = volume of foam AW−Volume of foam BW / volume of foam BW×100 Where, AW = after whipping, BW = before whipping

2.3 Pasting characteristics

The pasting properties of the whole wheat flours were measured using a starch cell of Modular Compact Rheometer (Anton Paar, MCR-52, Austria) by the method as described by(Kaur and Singh, 2016).

2.4 Biscuits preparation

Preparation of biscuits: biscuits were prepared with the incorporation of foxatil millet flour and whole wheat flour. Preparation was according to the recipe in Finney et al. (1950).

Method: All the ingredients were weighed as per the formulation given in table. The different biscuits were prepared with incorporation of foxtail millet flour. Foxtail millet was incorporated into the biscuits at10, 20, 30 and 40% (w/w) by replacing an equivalent amount of whole wheat flour in the biscuits mixture. Flours, baking powder, baking soda were sieved. Then all ingredients were mixed with hydrogenated fat to make dough. Milk (40 g) was also added to provide smoothness. Then the rolled out dough was spread on a tray, having a layer of fat, in a sheet of uniform thickness. Then the dough was cut into desired shapes with a cutter. The cut biscuits were placed on tray by placing a layer of fat on trays. The biscuits were baked at 180°C for 15 min. Baked biscuits were cooled and placed in polythene pouches and stored in an air tight container. After baking, the biscuits were cooled at room temperature and packed in polypropylene pouches. They were then sealed until sensory and textural analysis. Other biscuits intended for chemical analysis were ground into a finepowder, and stored at room temperature in air tight pouches.

2.5 Physical properties of biscuits

Biscuits were cooled for 2h after removing from oven at room temperature on a wire grid and weighed. Biscuits height was measured from the highest part of the biscuits to the bottom part using vernier calliper. Biscuits volume was determined by the rapeseed displacement method. Specific volumes were calculated by dividing volume by weight and expressing the results as milligram per gram.

2.6 Sensory evaluation of biscuits

The panel consists of the 10 members (5 semitrained and untrained) of department. The trained members were trained before the sensory evaluation. All the evaluation sessions were held in the laboratory of Food Science and Technology, C.D.L.U., Sirsa. The sensory evaluation was carried out after the biscuits preparation: color, appearance, texture, taste and overall acceptability of samples were evaluated following 9 hedonic scale. All the samples were presented in white tray and drinking water was provided for rinsing. The average valuesfor the sensory scores were used in analysis.

2.7 Statistical analysis of data

The data is an average of triplicate observations. Averages, one-way ANOVA and Least Significant Difference (LSD) were computed to measure variations in the observations with the help of MS-excel (Microsoft, Redmond, WA, USA) and Minitab 14 (Minitab Inc., State College, PA, USA).

3. Results and discussion

3.1 Proximate composition of wheat, foxtail millet and composite flours

Results of proximate composition of wheat flour (WF) and foxtail millet flour (FMF) and composite of flours are shown in Table 4.1. Significant differences ($p<0.05$) were observed for the proximate composition of flours. The moisture content, ash, fat, protein, crude fibre and carbohydrate content of WF and FMF was observed 10.13%, 1.63%, 1.9%, 11.7%, 1.11%, 73.53% and 9.6%, 1.67%, 2.8%, 12.1%, 3.25%, 70.58 %, respectively while

blend of FMF and WF (10%, 20%, 30% and 40%) varied from 8.35% to 9.43%, 1.63% to 1.68%, 2.1% to 2.6%, 11.8% to 12.60%, 1.23% to 2.1% and 71.59% to 74.59% values for moisture, ash, fat, protein, crude fibre and carbohydrate content respectively (Table 3).Kamara *et al.* (2009) reported that moisture, ash, fat, protein, dietary fibre, and carbohydrate varied from 11.50%, 3.06%, 9.35%, 3.10%, 4.25%, and 69.95% in foxtail millet flour.Sharma *et al.* (2017) reported that that moisture, ash, fat, protein, dietary fibre, and carbohydrate ranged, 12.3%, 4.3%, 9.36%, 3.3%, 4.55 and 60.9% for foxtail millet flour. Punia *et al*. (2017) reported ash, fat and fibre contents of wheat cultivars ranged between 1.52% to 1.76%, 2.62% to 3.48%, and 0.79% to 0.93%, respectively. Saxena *et al*. (1997) reported protein content of eight Indian wheat cultivars in the range from 8.1% to 11%.

3.2 Functional properties of foxtail millet and wheat flour

The wheat flour and foxatil millet flour were analyzed for their functional properties like water absorption capacity (WAC), oil absorption capacity (OAC), foaming capacity (FC), and emulsion activity (EA) (Table 4.2). WAC represents the ability of a product to associate with water under conditions where water is a limiting factor (Singh, 2001). According to Hodge and Osman, (1976), flours with high water absorption have more hydrophilic constituents, such as polysaccharides. Adebowale and Lawal, (2004) reported that flours with good OAC are potentially useful in flavour retention, improvement of palatability and extension of shelf life particularly in bakery or meat products where fat absorption is desired. For wheat flour the values of WAC and OAC were observed 2.57 g/g and 2.25 g/g, while foxtail millet flour had 1.96 g/g and 1.75 g/g. The WAC for composite flour ranged from 2.09 to 2.24 g/g, respectively, flour containing 10% foxtail millet flour had the lowest value. The OAC for composite flour ranged from 1.78 to 2.07 g/g, the highest and the lowest value were observed for flour containing 10% and 40% foxtail millet flour. Akubar *et al.* (2003) reported that the WAC and OAC of wheat flour were 1.40 and 1.46g/ml. Kaur *et al*. (2017) also reported WAC and OAC 2.68 and 2.36 g/ml for wheat flour. Sharma *et al*. (2016) reported that the WAC and OAC of foxtail millet flour were 1.68 g/ml and 1.48 g/ml.

FC and stability generally depend on the interfacial film formed by proteins, which maintains the air bubbles in suspension and slows down the rate of coalescence (Du *et al*., 2014). For wheat flour the FC was observed 10.96%. FC capacity of composite flour varied from 10.89 to 11.17%, respectively, the highest and the lowest value was observed for 10% and 40% foxtail millet flour sample. Foaming capacity of foxtail millet flour varied from

10.56 to 11.98% and foaming stability 91.45 to 93.98 ml (Amandu *et al*., 2011; Asharani *et al*., 2010).

Emulsion activity which repersent the ability of flour to emulsify oil. The emulsion activity reflects the ability and capacity of a protein to aid in the formation of an emulsion and is related to the protein's ability to absorb to the interfacial area of oil and water in an emulsion (Du *et al*. 2014). EA of wheat flour was 15.22%, whereas emulsion activity of foxtail millet was 16.85%. EA of composite flour varied from 15.16 to 15.49%, composite flour containing 40% foxtail millet had the highest value. Emulsifying activity of foxtail millet flour varied from 14.66 to 17.72%, respectively (Mohamed et al., 2009; Sharma *et al*., 2018).

3.3 Pasting properties of flours

Pasting properties of wheat flour and composite flours containing varying levels of foxtail millet flour are reported in table 4.3. Significant differences (P<0.05) in pasting properties among different flours were observed. All the flours showed gradual increase in viscosity with increase in temperature. The increase in viscosity with temperature may be attributed to the removal of water from the exuded amylose by the granules as they swell (Ghiasi *et al*., 1982). Peak viscosity (PV) , trough viscosity (TV), breakdown viscosity (BV),final viscosity (FV) and pasting temperature (PT) was observed 490 cP, 370 cP, 120 cP, 811 cP and 81.3ºC, respectively for wheat flour. PT provides an indication of the minimum temperature required to cook the flour. PT of flour blends varied from 80.03 to 80.4°C, the highest and lowest value was observed for sample containing 40% and 10% foxtail millet flour containing sample. PV viscosity of wheat flour was observed 490cP whereas PV varied from 290 to 470cP, respectively for composite flours. BV of the flour paste is defined as the difference between peak viscosity and trough viscosity. BV of composite flour varied from 79 to 150cP, sample containing 10% foxtail millet flour had the highest value. Final viscosity (indicates the ability of the material to form a viscous paste) and setback (measure of retro gradation tendency or syneresis of flours upon cooling of cooked flour pastes) of composite flours ranged from 620 cP to 853 cP and 409cP to 523cP, respectively. Singh and Singh, (2010) reported PV, BV, FV and PT of different wheat varieties in the range from 900 to 2618, 124 to 1151, 798 to 2667 cP and 65.3 to 82.5ºC, respectively. Yadav *et al.* (2012) reported PV, BV, TV and FV of 1362, 649, 1226 and 1938 cP, respectively for pearl millet flour.

3.4 Physical properties of biscuits

The physical properties of biscuits prepared from wheat flour with foxtail millet incorporation were analyzed for their physical properties and results are shown in table 4.4. It was observed that as the amount of foxtail millet was increased, nutritional values will be affected. The diameter of the biscuits increased with the incorporation of foxtail millet flour varied from 50.11mm to 50.70mm, control biscuits had the highest value while the lowest value was observed for biscuit containing 10% foxtail millet flour. The thickness of biscuits varied from 4.73mm to 5.02mm. The thickness of biscuits increased with the incorporation of foxtail millet flours and thickness varied respectively from 4.82 to 5.02mm. The highest thickness of biscuits made from foxtail millet flour 40% whereas the lowest thickness of biscuits made from wheat flour. The spread ratio (ratio of average value of diameter by average value of thickness of biscuits) of biscuits made from wheat flour was found highest 10.71mm and incorporation of foxtail millet flour reduced spread ratio, ranged from 10.05mm to 10.39mm. The lowest spread ratio of biscuits made from 40% foxtail millet flour. Weight of biscuits made from wheat flour was observed 8.92g whereas biscuit made from composite had weight 9.22g to 9.61g, the highest weight was observed for biscuit made from 40% foxtail millet flour. Kaur *et al.* (2015) reported that with the incorporation of buckwheat flour increase the thickness and weight of biscuits whereas spread ratio and diameter of biscuits decrease with increase incorporation of buckwheat flour. The thickness and weight of biscuits range from 7.56 to 8.45mm, 10.57 to 12.70g, the lowest thickness and weight of biscuits of wheat flour. The diameter and spread ratio of biscuits range from 62.08 to 63.41mm and 7.34 to 8.38mm. The highest diameter and spread ratio was observed for wheat flour biscuits.

3.5 Proximate composition of biscuits

Proximate composition of biscuits prepared from composite flour of wheat and foxtail millet flour is shown in table 4.5. The fat and crude fibre content of composite biscuits varied 20.18% to 20.47% and 2.13 to 2.31%, respectively, whereas for control biscuits values were 20.02% and 1.98%. The ash content of the biscuits increase with addition of foxtail millet flour. The ash content of biscuits was ranged from 1.49 to 1.91%, the highest contentobserved for 40% foxtail millet flour biscuits and the lowest value was observed for control biscuit. The moisture content of biscuits ranged from 2.42 to 3.87%, control biscuits had highest moisture content. Protein content of biscuits ranged from 9.78 to 10.25%. The carbohydrate content of biscuits ranged from 62.86 to 63.17%. Control sample had the lowest carbohydrate content whereas 20% composite had highest carbohydrate value. Adebiyi *et al*. (2017) reported ash, carbohydrate, crude fat, crude fibre, crude protein and moisture content 1.23%, 64.48%, 18.77%, 1.75%, 8.01%, and 5.77% for pearl millet flour biscuit. Obafaye *et al*. (2018) resulted moisture, crude ash, crude fat, crude fibre, crude protein and carbohydrate 5.16%, 2.01%, 24.31%, 0.25%, 16.79% and 51.49% for biscuits prepared from millet flour.

3.6 Sensory properties of different biscuits made from foxtail millet flour and wheat flour

Sensory evaluation is an important aspect to be considered in the development and evaluation of a new product. Consumer acceptability tests were used to investigate consumer preferences and to know the level of acceptance based on the magnitude of their responses (likes and dislikes) (Adebiyi *et al*., 2017). Biscuit prepared from wheat flour and composite flours were evaluated for various sensory properties like shape, color, flavor, texture, taste and overall acceptability. The judges scored quality characteristics of each sample on a nine- point hedonic rating score. The sensory score obtained were represented in table 4.6. Among the biscuits made from foxtail millet flour and wheat flour, the color, appearance, texture, and the taste of 20% foxtail millet was more better than the other three sample containing foxtail millet flour. The highest overall acceptability was observed for control biscuits, 10% FMF and 20% FMF biscuits while lowest score was obtained for 40% foxtail millet flour biscuits. The color of biscuits becomes darker with increase addition of foxtail millet flour. Control biscuits, 10%, 20% composition were having goods flavor, appearance, texture, taste while 30%, 40% foxtail millet flour biscuits were having false flavor and pore size get increased and appearance of biscuits were also affected. The hedonic test showed a pleasant appreciation for all the biscuits except 40% composition biscuits. Biscuits from 10% and 20%

FMF in the blend were favorably scored to the control sample, which was scored highest in all sensory attributes. Sample containing more than 20% were poorly scored as compared to the control.

Conclusion

It was observed that after the addition of foxtail millet flour ash, fibre, fat and protein content of composite flour was increased with increase the amount of foxtail millet flour. Significant differences ($p<0.05$) were observed for functional properties of composite flour as compared to the wheat flour. Functional properties were improved with addition of foxtail millet flour. Pasting properties of composite was differing from wheat flour. PV, BV, TV and FV were decreased with addition of 20, 30, and 40% foxtail millet flour into the wheat flour. It was observed that diameter and spread ratio decreased whereas thickness and weigh of biscuits was increased as compared to control sample. It was observed that ash, fat, protein and fibre content was increased as compared to control biscuit. The hedonic test showed a pleasant appreciation for all the biscuits except 40% composition biscuits. Biscuits from 10% and 20% FMF in the blend were favourably scored to the control sample.

References

Adebiyi, J.A., Obadina, A.O., Adebo, O.A., and Kayitesi, E. (2017). Comparison of nutritional quality and sensory acceptability of biscuits obtained from native, fermented, and malted pearl millet (Pennisetum glaucum) flour. *Food Chemistry*, (232), 210-217.

AOAC, Association of Official Analytical Chemists, Washington, D.C., (1990). *Official Methods of Analysis*, 15th edn.

Adebowale, K.O., and Lawal, O.S. (2004). Comparative study of the functional properties of bambarra groundnut, jack bean and mucuna bean flours. *Food Research International*, 37(4), 355-365.

Ajila, C.M., Leelavathi, K., and Prasada Rao, U.J.S. (2015). 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.

Akubar, P.I., Benje, F.N., and Obiegbuna, J.E. (2003). Effect of cowpea supplementation on the functional and biscuit making properties of wheat flour. *Journal Sustainable Agricultural Environment*, (5), 247 – 253.

Anand, P., Kunnumakara, A.B., Sundaram, C., Harikumar, K.B., Tharakan, S.T. and Lai, O.S. (2008). Cancer is a preventable disease that requires major lifestyle changes. *Pharmaceutical Research*, 25(9), 2097–2116.

Anju, T., and Sarita, S. (2010). Suitability of foxtail millet (*Setaria italica*) and barnyard millet (*Echinochloa frumentacea*) for development of low glycemic index biscuits. *Journal Food Science and Nutrition* 16(3), 361-368.

Asharani, V.T., Jayadeep, A., and Malleshi, N.G. (2010). Natural antioxidants in edible flours of selected small millets. *International Journal of Food Properties*, 13(1), 41-50.

Balasubramanian, S. (2013). Processing of millets. In *Paper* presented National Seminar on Recent Advances in processing, utilization and nutritional impact of small millets. *Madurai Symposium, Thamukkam Grounds, Madurai*.

Chandrasekara, A., and Shahidi, F. (2011). Bio-accessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. *Journal of Functional Foods*, (4), 226–37.

Du, S., Jiang, H., Ai, Y., and Jane, J. (2014). Physicochemical properties and digestibility of common bean (Phaseolus Vulgaris L.) starchs. *Carbohydrate Polymer*, (108), 200-205. FAO, (Food and Agricultural Organization of the United Nations) (2017). The statistical division. http://www.fao.org/faostat/en/#data/QC (Accessed 15 June 2019).

Finney, K. F., Yamazaki, W. T., and Morris, V. H. (1950). Effects of varying quantities of sugar, shortening and ammonium bicarbonate on the spreading and top grain of sugar snap cookies. *Cereal Chemistry*, (27), 30-41.

Sosulski, F.W. (1962). *Cereal Chemistry*, (39), 344.

Florence-Suma, P., Urooj, A., Asha, M. R., and Rajiv, J. (2012). Sensory, physical and nutritional qualities of cookies prepared from pearl millet (*Pennisetum typhoideum*). *Journal of Food Processing and Technology*, (5), 2-6.

Ghiasi K., Varriano-Marston K., and Hoseney R.C. (1982). Gelatinization of wheat starch. II. Starch-surfactant interaction. *Cereal Chemistry*, 59(2), 59-86.

Gopalan, C., Ramasashtri, B.V., and Balasubramanian, S.C. (2007). Nutritive Value of Indian Foods. *National Institute of Nutrition, ICMR: Hyderabad, India*, 23(8), 47-51.

Leach H.W., Mc Cown L.D., and Schoch T.J. (1959). *Cereal Chemistry*, (36), 535.

Hodge, J.C., and Osman, E.M. (1976). Carbohydrates, principles of food science, Part I. *Food chemistry*, 97-200.

ICAR (Indian Council of Agricultural Research) (2005-2006). Crop improment and mangement. http://icar.org.in/data (Acce ssed 12 October 2005).

Issoufou Amadou, Mahamadou E. G., and Guo-Wei Le (2011). Millets: Nutritional composition, some health benefits and processing. *Journal Food Agricultural*, 25 (7), 501-508.

Kamara, M.T., and Kexue, Z. (2009). Extraction, Characteriziesation and Nutritional Properties of two varieties of defatted foxtail millet flour (Setaria italic L.) grown in china. *Asian Journal of Biochemistry*, 4(3), 88-98.

Kaur, K., Kaur, H., and Bains, K. (2017). Development and Nutritional Evaluation of cereal and pulse based biscuits for diabetic patients. *British Journal of Applied Science and Technology*, 21(5), 1-8.

Kaur, M., Sandhu, K. S., Arora, A., and Sharma, A. (2015). Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: physicochemical and sensory properties. *LWT-Food Science and Technology*, 62(1), 628-632.

Khatker and Schofield, (1997). Molecular and Physico-chemical basis of bread making- Properties of wheat glutan proteins. *Journal of Food Science and Technology, Mysore*, 34(2), 85-102.

Lata, C., Gupta, S., and Prasad, M. (2013). Foxtail millet: a model crop for genetic and genomic studies in bioenergy grasses. *Critical Reviews in Biotechnology*, 33(3), 328–343.

Malm, N. R., and Rachie, K. O. (1971). The Setaria millets. *A Review of The World Literature*, (513), 15-16.

M. Kaur, S. Singh, (2016). International Journal. Food Properties (19), 2432.

Lin M.J.Y., Humbert E.S., and Sosulski F.W. (1974). International Journal. Food Properties, (39), 368.

Misra, N.N., and Tiwari, B.K. (2014). Biscuits. *Bakery Products Science and Technology*,585-601.

Mohamed, T.K., Zhu K., Issoufou A., Fatmata T., and Zhou H. (2009). Functional, in vitro digestibility and physicochemical properties of two varieties of defatted foxtail millet protein concentrates. *Inernational Journal Molecular Sci*ence, (10), 5224- 5238.

Murtaugh, M. A., Ma, K. N., Benson, J., Curtin, K., Caan, B., and Slattery, M. L. (2004). Antioxidants, carotenoids, and risk of rectal cancer. *American Journal of Epidemiology*, 159(1), 32-41.

Muthamilarasan, M., Dhaka, A., Yadav, R., and Prasad, M. (2016). Exploration of millet models for developing nutrient rich graminaceous crops. *Plant Science*, *(*242), 89–97.

NIN, (2007). Nutritive value of Indian Foods, Ed Gopalan and Deosthale. *National Institute of Nutrition*, Hyderabad.

Narayana, K., and Narasinga Rao, M. S. (1982). Functional properties of raw and heat processed winged bean flour. *Journal of Food Science*, (42), 534-538.

Obafaye, R.O., and Omoba, O.S. (2018). Orange peel flour: A potential sources of antioxidant and dietary fibre in pearl-millet biscuit. *Journal of Food Chemistry*, 42(4), 12- 23.

Park, K.O., Ito, Y., Nagasawa, T., Choi M.R., and Nishizawa N. (2008). Effects of dietary Korean foxtail-millet protein on plasma adiponectin, HDL cholesterol, insulin levels, and gene expression in obese type 2 diabetic mice. *Bioscience Biotechnology Biochemistry*, 72(11), 2918–2925.

Punia, S., Sandhu K.S. and Siroha, A.K. (2017). Difference in protein content of wheat (*Triticum aestivum L*.): Effect on functional, pasting, color and antioxidant properties. *Journal of the Saudi Society of Agricultural Sciences.*

Saxena, D.C., Prasada Rao, U.J.S., and Haridas Rao, P. (1997). Indian wheat cultivars: correlation between quality of gluten properties, reheological characteristics of dough and tendoori roti quality. *Journal of Science of Food and Agricultural*, (74), 265-272.

Sharma, N., and Niranjan, K. (2017). Foxtail millet: Properties, processing, health benefits, and uses. *Food Reviews International*, 34(4), 329-363.

Sharma, N., Goyal, S. K., Alam, T., Fatma, S., and Niranjan, K. (2018). Effect of germination on the functional and moisture sorption properties of high–pressure- processed foxtail millet grain flour. *Food and Bioprocess Technology*, 11(1), 209-222.

Sharma, N., Goyal, S. K., Alam, T., Fatma, S. and Niranjan, K. (2018). Effect of germination on the functional and moisture sorption properties of high–pressure- processed foxtail millet grain flour. *Food and Bioprocess Technology*, 11(1), 209-222.

Sharma, S., Dharmesh C.S., and Charanjit S. Riar (2016). Nutritional, sensory and in- vitro antioxidant characteristics of gluten free cookies prepared from flour blends of minor millets. *Journal of Cereal Science* (72), 153 – 161.

Singh, S., and Singh N. (2010). Effect of debranning on the physic-chemical, cooking, pasting and textural properties of common and durum wheat varieties. *International FoodResearch Journal*, 43(9), 2277-2283.

Singh, U. (2001). Functional properties of grain legume flours. *Journal of Food Science and Technology*, 38(3), 191-199.

Sweta Rai, Amarjeet Kaur and Baljit Singh (2014). Quality characteristics of gluten free cookies prepared from different flour combinations. *Journal of Food Science and Technology*, 51(4), 785 - 789.

Yadav, B.S., Ritika, B.Y., and Roshan, L.Y. (2012). Studies on functional properties and incorporation of buckwheat flour for biscuit making. *International Food Research Journal*, (17), 1067 – 1076.

Yasumatsu, K., Sawada, K., Maritaka, S., Mikasi, M., Toda, J., and Wada, T. (1972).Whipping and emulsifying properties of soybean products. *Agricultural and Biological Chemistry*, (36), 719-727.

Zia-Ul-Haq, M., Ahmad, S., Bukhari, S.A., Amarowicz, R., Ercisli, S., and Jaafar, H.Z.E. (2014). Compositional studies and biological activities of some mash bean (Vigna mungo (L.) Hepper) cultivars commonly consumed in Pakistan. *Biological Research*, 47(1), 23- 31.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Table 1: Formulation used for the preparation of biscuits with the incorporation of foxtail millet flour

Ingredient	WF100%	WF+FMF10%	WF+FMF20%	WF+FMF30%	WF+FMF40%
WholeWheat Flour (g)	100	90	80	70	60
FoxtailMillet Flour (g)	0	10	20	30	40
Sugar (g)	50	50	50	50	50
Fat (g)	18	18	18	18	18
Sodium Bicarbonate (g)	0.50	0.50	0.50	0.50	0.50
Milk (g)	40	40	40	40	40
Salt (g)	1.50	1.50	1.50	1.50	1.50

WF: Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour **WF+FMF-30%:** Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

Table 2: Proximate composition of wheat flour, foxtail millet and composite flour

Sample	Moisture(%)	Ash(%)	Fat (%)	Protein(%)	Crude fiber (%)	Carbohydrate (%)
WF	10.13b±2.11	1.63a±0.12	1.9a±0.09	11.7a±1.06	1.11a±0.08	73.53ab±3.32
FMF	9.6ab±0.66	1.67a±0.08	2.8c±0.25	12.1ab±1.02	3.25b±0.44	70.58a±4.46
WF+FMF-10%	8.35a±1.12	1.63a±0.09	2.1ab±0.12	11.8a±1.45	1.23a±0.18	74.89b±5.10
WF+FMF-20%	8.95ab±1.08	1.64a±0.15	2.2ab±0.42	11.8a±1.22	1.64ab±0.25	73.77ab±4.48
WF+FMF-30%	9.30ab±1.02	1.66a±0.17	2.2ab±0.32	11.9a±2.08	1.85ab±0.09	73.09ab±2.45
WF+FM-40%	9.43ab±1.45	1.68a±0.25	2.6b±0.24	12.60b±2.11	2.1ab±0.22	71.59a±5.08

Values expressed are average of n = 3 (± standard deviation). Averages in a column with different superscript (a-c) are significantly different ($P \leq 0.05$). **WF:** Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour
WF+FMF-30%: Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

Table 3: Functional properties of foxtail millet, wheat and composite flour

Sample	Water Absorption Capacity (g/g)	Oil Absorption Capacity (g/g)	FoamingCapacity (%)	EmulsionActivity (%)
WF	2.57b±0.28	2.25b±0.48	10.96a±2.24	15.22a±0.98
FMF	1.96a±0.30	1.75a±0.09	11.82b±1.26	16.85b±1.55
WF+FMF-10%	2.09a±0.55	1.78a±0.28	10.89a±2.32	15.16a±3.12
WF+FMF-20%	2.13ab±0.12	1.87ab±0.25	10.97a±1.22	15.25a±2.05
WF+FMF-30%	2.18ab±0.13	1.98ab±0.33	11.06a±1.01	15.31a±2.11
WF+FM-40%	2.24ab±0.18	2.07ab±0.15	11.17ab±1.44	15.49ab±1.44

Values expressed are average of n = 3 (± standard deviation). Averages in a column with different superscript (a-c) are significantly different ($P \leq 0.05$). **WF:** Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour
WF+FMF-30%: Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

Table 4: Pasting properties wheat, foxtail and blends of flours

Sample	Peak viscosity (cP)	Breakdown viscosity (cP)	Trough viscosity (cP)	Setback viscosity (cP)	Final viscosity (cP)	Pasting temperature (°C)
WF	490	120	370	441	811	81.7
WF+FMF-10%	470	150	320	523	853	80.03
WF+FMF-20%	420	110	310	510	790	80.3
WF+FMF-30%	360	99	261	460	721	80.3
WF+FM-40%	290	79	211	409	620	80.4

WF: Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour **WF+FMF-30%:** Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

Table 5: Physical properties of biscuits

Sample	Diameter(mm)	Thickness (mm)	Spread Ratio (mm)	Weight(mm)
WF	50.70a±2.31	4.73a±0.12	10.71a±0.54	8.92a±0.48
WF+FMF-10%	50.11a±2.88	4.82a±0.12	10.39a±0.45	9.22ab±0.43
WF+FMF-20%	50.23a±1.98	4.91a±0.09	10.23a±0.32	9.52ab±0.42
WF+FMF-30%	50.17a±1.22	4.98a±0.11	10.07a±0.35	9.31ab±0.22
WF+FM-40%	50.47a±2.11	5.02a±0.21	10.05a±0.65	9.61ab±0.12

Values expressed are average of n = 3 (± standard deviation). Averages in a column with different superscript (a-c) are significantly different ($P \leq 0.05$). **WF:** Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour
WF+FMF-30%: Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

Table 6: Proximate composition of biscuits

Sample	Ash(%)	Moisture (%)	Fat(%)	Protein(%)	Fibre(%)	Carbohydrates (%)
WF	1.49a±0.12	3.87b±0.22	20.02a±1.12	9.78a±0.62	1.98a±0.05	62.86a±3.21
WF+FMF-10%	1.52a±0.08	3.02ab±0.42	20.17a±2.25	10.02ab±0.32	2.13a±0.12	63.15ab±2.32
WF+FMF-20%	1.62a±0.08	2.72a±0.15	20.21a±2.44	10.09ab±0.44	2.19a±0.22	63.17ab±2.85
WF+FMF-30%	1.79ab±0.09	2.56a±0.80	20.33a±2.20	10.20ab±0.42	2.25a±0.09	62.87b±5.65
WF+FM-40%	1.91b±0.07	2.42a±0.40	20.47a±1.88	10.25ab±0.14	2.31a±0.21	62.64b±2.12

Values expressed are average of n = 3 (± standard deviation). Averages in a column with different superscript (a-c) are significantly different ($P \leq 0.05$). **WF:** Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour
WF+FMF-30%: Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Table 7: Sensory properties of different biscuits

Characteristic s	Shape	Color	Texture	Taste	Flavor	Overall Acceptability
WF	7.11a±1.87	6.9ab±0.21	7.6ab±0.65	7.7bc±0.45	7.5b±0.22	7.42bc±1.22
WF+FMF-10%	7.16a±1.25	7.4ab±0.25	7.5ab±0.54	7.3bc±0.65	7.3b±0.58	7.4bc±0.98
WF+FMF-20%	7.23a±0.64	8.2b±0.54	7.9ab±0.65	7.2bc±0.56	8.0c±0.35	7.52bc±0.45
WF+FMF-30%	7.06a±0.62	6.5ab±0.65	6.3ab±0.98	6.4b±0.98	6.1b±0.32	6.4b±0.78
WF+FM-40%	6.72a±0.23	5.7a±0.32	5.3a±0.87	4.2a±0.32	4.8a±0.21	5.24a±0.87

Values expressed are average of n = 3 (± standard deviation). Averages in a column with different superscript (a-c) are significantly different ($P \leq 0.05$). **WF:** Wheat flour, **FMF:** Foxtail millet flour, **WF+FMF-10%:** Wheat flour incorporated with 10% foxtail millet flour, **WF+FMF-20%:** Wheat flour incorporated with 20% foxtail millet flour
WF+FMF-30%: Wheat flour incorporated with 30% foxtail millet flour**, WF+FMF-40%:** Wheat flour incorporated with 40% foxtail millet flour.