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Development of Process for Foxtail Millet and Barnyard Millet Biscuits

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ABSTRACT: This experimental paper aims to develop the process of incorporating foxtail millet flour and barnyard millet flour in biscuit formulations. Different blends of millet flours were used, including T1 (100% barnyard millet flour), T2 (25% foxtail millet flour + 75% barnyard millet flour), T3 (50% foxtail millet flour + 50% barnyard millet flour), T4 (75% foxtail millet flour + 25% barnyard millet flour), and T5 (100% foxtail millet flour). The biscuits underwent physical, chemical, textur analyses and sensory analyses to evaluate their properties. The results revealed that as the proportion of foxtail millet flour increased, the moisture content of the biscuits also increased. The ash content varied between 1.88% and 2.85%. The protein content was highest in T5 (11.22 g/100g) and lowest in T1 (8.81 g/100g), indicating an increase with an increase in foxtail millet flour. The fat content ranged from 26.32 g/100g in T1 to 28.12 g/100g in T5. The fiber content decreased with an increase in foxtail millet flour, while the carbohydrate content decreased with a decrease in fiber and an increase in protein and fat. The water activity decreased as the moisture content decreased. The iron content decreased significantly with an increase in the proportion of foxtail millet flour, while the calcium content increased. The diameter and spread ratio of the biscuits decreased, while the thickness, density, and weight increased with an increase in foxtail millet flour. The color of the biscuits became lighter with an increase in foxtail millet flour. The textural properties varied among the different blends, with T2 showing better firmness and crispness, and T4 exhibiting high fracturability. In the cutting test, T1 and T2 had softer textures, while T4 and T5 had harder and crispier textures. The sensory evaluation indicated that the blend of 50% foxtail millet flour and 50% barnyard millet flour (T3) was preferred in terms of color, taste, flavor, texture, appearance, and overall acceptability.

KEYWORDS: Foxtail millet, Barnyard millet, Biscuit, Nutritional quality, Physical properties, Sensory characteristics, textural Properties.

I. INTRODUCTION

Millets are traditional grains, grown and consumed in the Indian subcontinent from the past more than 5000 years. Millets are small - grained, annual, warm - weather cereals belonging to grass family. They are rainfed, hardy grains which have low requirements of water and fertility when compared to other popular cereals. Millets have played a significant role as a staple meal, especially in Asia and Africa. Millets are easily available and are cheap in price. They are generally highly adaptable and can be grown in practically any circumstance (Shadang and Jaganathan, 2014).

Foxtail millet, belonging to the Poaceae family, is one of the world's oldest cultivated crops, known for its drought-resistant nature and high nutritional value. It is a staple food in many Asian and African regions and is rich in protein, fiber, minerals, and phytochemicals.

On the other hand, barnyard millet, also known as Japanese barnyard millet, is another



traditional grain with significant nutritional benefits(Verma *et al.*, 2015). It is an essential crop due to its high protein content, soluble and insoluble fiber, and slow-digesting carbohydrates, making it suitable for modern sedentary lifestyles. The combination of foxtail millet and barnyard millet flours in biscuit preparation offers an opportunity to enhance dietary quality and promote food security. These biscuits are not only delicious but also provide valuable nutrients, making them an ideal choice for health-conscious consumers and those seeking alternatives to mainstream cereal-based products(Kaur *et al.*, 2020).

Biscuits are a rapidly expanding food category in India because of their low moisture content and long shelf life. Consumers are increasingly demanding convenient and wholesome food items. The demand from consumers for high-quality food products that are savoury, secure, practical, and nourishing has increased. As a result, nutrition has become a new component in the process of creating food products. Due to market competition and growing consumer demand for healthy, natural, and useful products, efforts are being made to adjust the nutritional composition of biscuits to raise their nutritive value and functionality (Tyagi 2007)

II. WORK DONE

The primary objectives of this study are:

1) Physical analysis: Physical analysis of biscuits involves the evaluation and characterization of various physical properties like diameter, thickness, spread ratio, volume and density of biscuits. The physical properties of biscuits play a crucial role in consumer acceptance and preference.

2)Nutritional analysis: Nutritional analysis of biscuits provides important information about the moisture content, protein, fibre, ash, fat, carbohydrate, iron and calcium of biscuits, which is crucial for understanding their contribution to the overall diet and assessing their potential health benefits or concerns.

3)Textural analysis: Textural analysis of biscuits can be conducted using bending and cutting tests to evaluate their mechanical properties, such as hardness, brittleness, and crumbliness.

III. METHODOLOGY

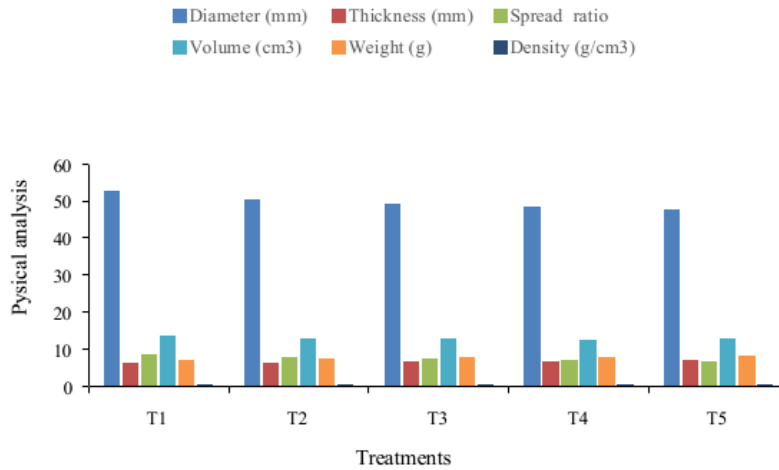
The present study was conducted in College of Technology and Engineering, MPUAT (Udaipur).The foxtail millet and barnyard millet grains were cleaned to remove dust and other foreign materials. The cleaned foxtail millet and barnyard millet grains were milled separately in flour mill in the Department of Processing and Food Engineering, CTAE Udaipur. Flour was sieved using a BS 40 mesh sieve to obtain fine flour and was stored in the air tight container till it completion

Preparation of Biscuits

The biscuits were prepared following the recipe by Sudha et al., 2007, using the creaming method. Accurate measurements of foxtail millet flour, barnyard millet flour, and powdered sugar were taken with a digital weighing balance. These dry ingredients were sieved twice to remove any impurities. Softened butter and powdered sugar were creamed together for about 10 minutes until light and fluffy. The flour was then gently mixed in to create a smooth dough. The dough was rolled to a thickness of 0.6 cm using a wooden rolling pin and cut into round shapes with a metallic cutter. The biscuits were arranged on a baking tray and baked at 180oC for 16 minutes. After baking, the biscuits were cooled on a rack, packed, and stored at room temperature for evaluation.

Table 3.1 proportion of foxtail millet and barnyard millet

Sample	Foxtail millet flour (gm)	Barnyard millet flour (gm)
T ₁	0	100
T ₂	25	75
T ₃	50	50
T ₄	75	25
T ₅	100	0



Physical properties- Diameter, thickness and spread ratio are measured with the help of a ruler while density is measured as ratio of weight and volume. (Sindhuri 2018)

Physio-chemical Analysis-

1. Moisture content is measured by the hot air oven method (AOAC, 2005)
2. Protein is calculated according to the Micro Kjeldahl technique (AOAC, 2005)
3. Fibre and Fat are estimated using Soxhlet apparatus
4. Ash content is found out with the help of muffle furnace
5. Carbohydrate = 100 – (fat% + fibre% + ash% + protein% + moisture%)
6. Water activity was measured with the help of a digital water activity meter
7. For estimation of minerals like Iron and Calcium flame photometer is used.

Sensory analysis- Sensory analysis was done on the nine-point hedonic scale and scores were given by a panel of 15 judges (Khedkar, 2004).

Color analysis- It is done with the help of Hunter lab calorimeter (Pomeranz and Meloan, 1971)

Texture analysis- Cutting and bending test are the two main tests done to analyse the texture of the prepared biscuits using a texture analyzer.

IV. EXPERIMENTAL RESULTS

Physical Properties-

Physical analysis of biscuits

Table 4.1 Effect of treatments on Physical analysis of biscuits

treatment (%)	Diameter (mm)	Thickness (mm)	Spread ratio	Spread factor	Volume (cm ³)	Weight (g)	Density (g/cm ³)
T1	52.64	6.18	8.52	85.2	13.44	7.14	0.52
T2	50.31	6.38	7.88	78.8	12.69	7.35	0.55
T3	49.22	6.65	7.39	73.95	12.65	7.63	0.62
T4	48.15	6.76	7.12	71.2	12.30	7.90	0.65
T5	47.52	7.12	6.67	66.7	12.63	8.32	0.66

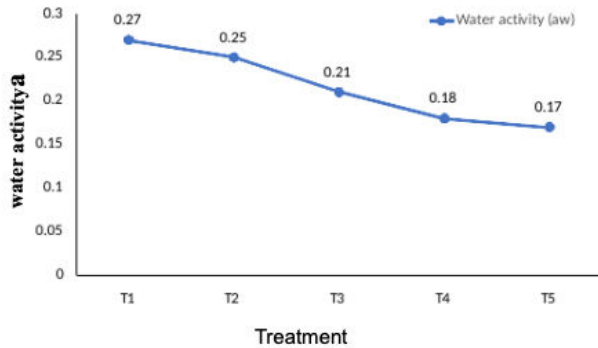


Fig 4.4 Graphical representation of water activity

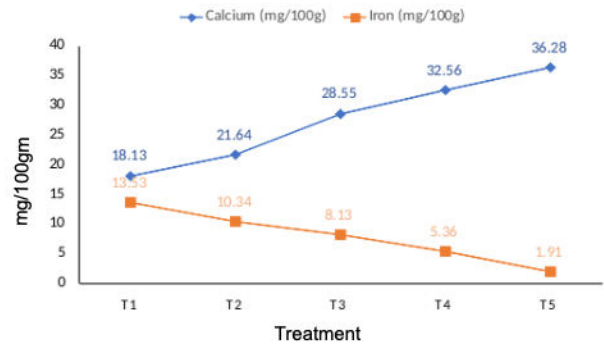
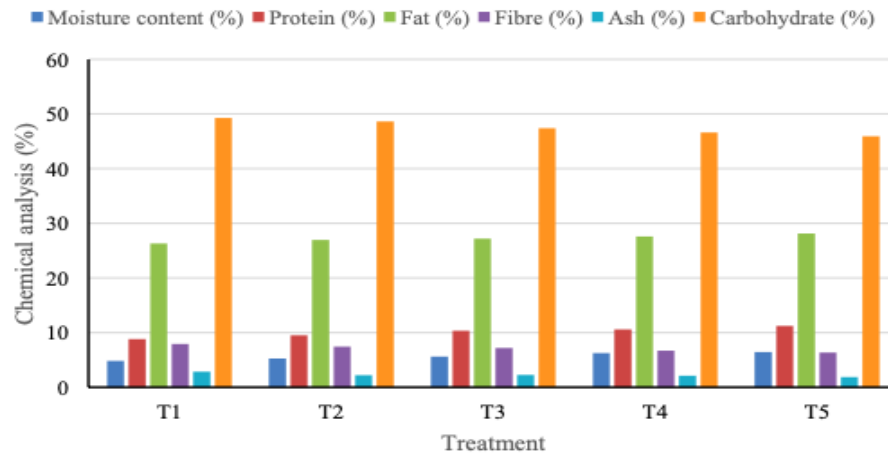
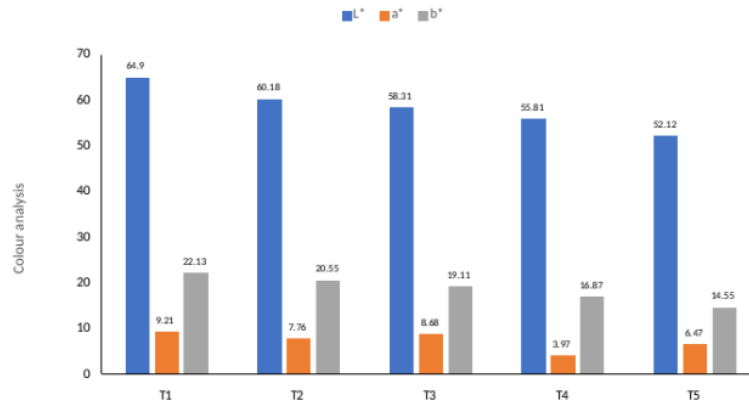


Fig 4.3 Graphical representation of iron and calcium

Physio-chemical Analysis-

Treatment (%)	Moisture content (%)	Protein (%)	Fat (%)	Fibre (%)	Ash (%)	Carbohydrate (%)	Iron (mg/100)	Calcium (mg/100)	Water activity (aw)
T ₁	4.82	8.81	26.32	7.91	2.83	49.29	13.53	18.13	0.27
T ₂	5.24	9.51	26.93	7.42	2.23	48.66	10.34	21.64	0.25
T ₃	5.62	10.34	27.18	7.17	2.26	47.41	8.14	28.55	0.21
T ₄	6.27	10.58	27.60	6.71	2.09	46.62	5.36	32.56	0.18
T ₅	6.45	11.22	28.12	6.33	1.88	45.95	1.91	36.28	0.17

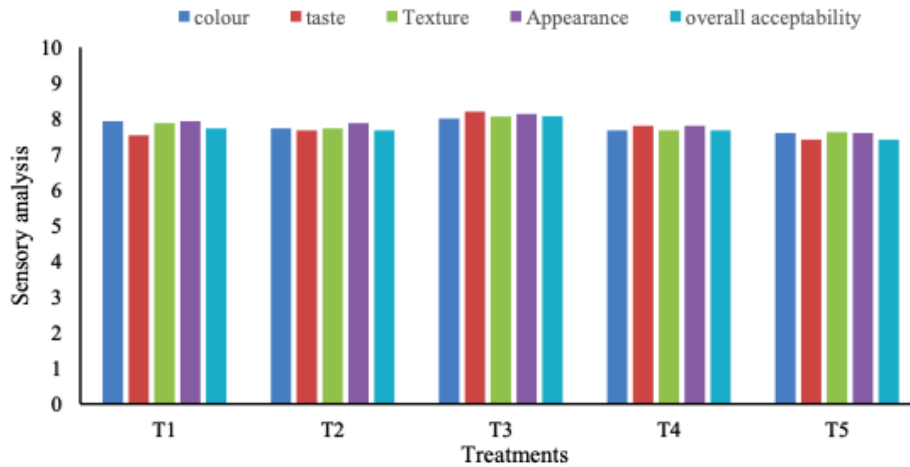




Treatment	Score of sensory analysis				
	colour	taste	Texture	Appearance	overall acceptability
T1	7.93	7.53	7.87	7.93	7.73
T2	7.73	7.67	7.73	7.87	7.67
T3	8.0	8.2	8.06	8.13	8.07
T4	7.67	7.8	7.67	7.8	7.67
T5	7.60	7.41	7.62	7.6	7.41

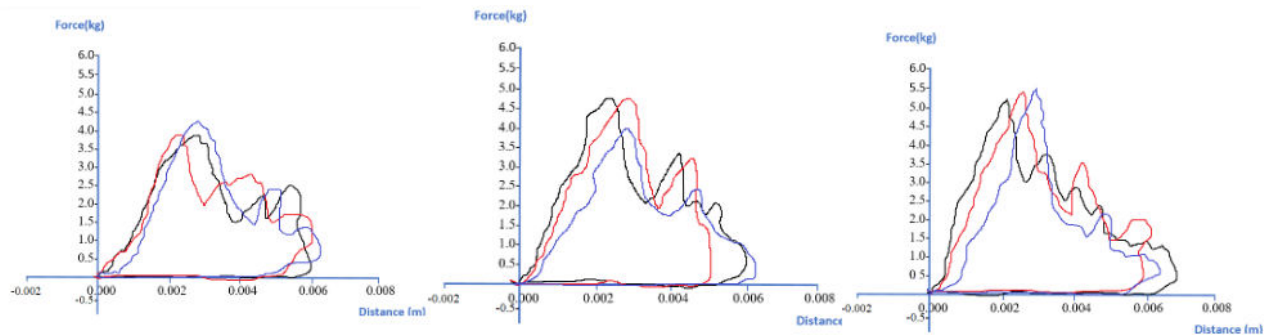
Sensory Analysis-

Proportions of foxtail millet flour affected the colour, texture, taste and overall acceptability of biscuits. The scores for flavour and appearance were almost same for all treatments. The composition 50% foxtail millet flour+50% barn-yard millet flour i.e.T3 was best for colour, texture, taste, appearance, overall acceptability and was most accepted by the judges of consumer panel.

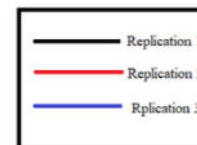


Color Analysis-

Colour measurement of different proportion of foxtail millet and barnyard millet base biscuits was carried out by Hunter Lab. The instrument described the colour in three dimensions namely “L”, “a” and “b”. “L” indicates lightness/darkness (100-0) it distinguishes light colour from dark or white from black. “a” indicate the redness with positive value and greenness with negative value and “b” described the shade of yellow varying to blue colour (from positive value to negative value) (Pomernanz and Meloan, 1971).

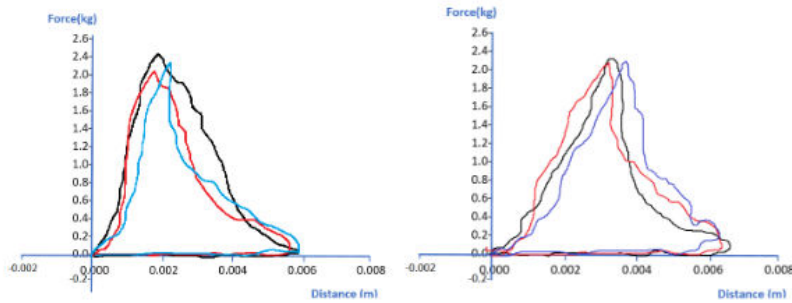
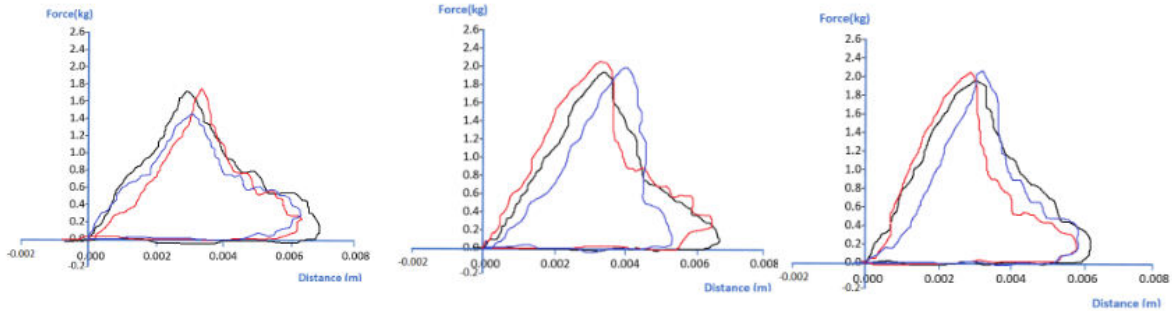


Graphical representation of L*, a* and , b* values of biscuit

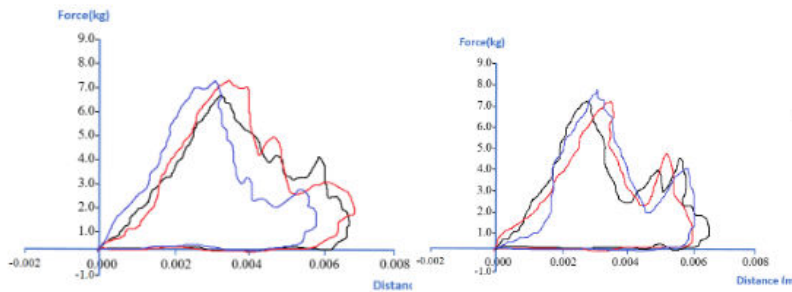
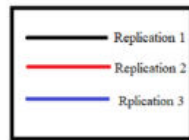




Textural Analysis-



Graphical representation of cutting tests of texture analysis



Graphical representation of bending tests of texture analysis

V. CONCLUSION

in conclusion, the increase in protein and fat content in biscuits resulted in a decrease in diameter, spread ratio, spread factor, and density. Moisture content increased with an increase in foxtail millet flour, while ash content increased with an increase in fiber content and the proportion of foxtail millet and barnyard millet flour. Fiber content increased with an increase in barnyard millet flour, and protein increased with an increase in foxtail millet. Fat content decreased with an increase in barnyard millet. Water activity decreased with a decrease in fiber content. Carbohydrate decreased with a decrease in fiber and moisture, and ash content increased with an increase in protein and fat. Biscuit combination T2 (25% foxtail millet flour + 75% barnyard millet flour) exhibited better firmness and crispness in the bending or snap test. Sample T4 had high fracturability and broke at a short distance, indicating a less desirable texture. Biscuits with higher foxtail millet flour content (T5) showed maximum hardness and work of shear in the cutting test, requiring more force to shear. Overall, the proportion of foxtail millet flour influenced the color, texture, taste, and overall acceptability of the biscuits. The composition with 50% foxtail millet flour and 50% barnyard millet flour (T3) received the best scores for color, texture, taste, appearance, and overall acceptability from the consumer panel.

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