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Standardization of Pearl millet chapati

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Abstract

The present study was carried out with an aim of standardization. The purpose of this research was to explore enhancing the quantity of pearl millet chapati. Nutrients mainly zinc and to overcome the effect of goitrogens, which can affect thyroid. A focus was on thickness and diameter of control pearl millet chapati and their storage capacity. Physical characteristics such as swelling capacity of flour and water-soluble flour fraction, and chemical characteristics such as crude fibre, moisture, ash and fat content in pearl millet, sorghum and oat flour were determined. Water absorption and damaged starch were found to be important parameters for chapati quality as both parameters had significant positive effect on the pliability and puffing height of chapati.

Keywords: Pearl millet, Chapati, Goitrogens, Sorghum, Oat, Nutrients.

1. INTRODUCTION

Pearl millet (*Pennisetum typhoideum, P glaucum, P americanum or spicatum),* local Indian name "Bajra", is the third most produced cereal crop after wheat (*Triticum aestivum*) and rice (*Oryza sativa*) in India and common in tropical semi-arid areas mainly in Africa and Asia. It is particularly important in western India (Gujarat, Rajasthan and Haryana). Pearl millet is often grown in areas with low rainfall(200-600mm), low soil productivity, and high temperature but can also it can be grown where wheat or maize would not be viable. In India, pearl millet occupies an area of 6.93 million ha with an average production of 8.61 million tonnes. It is a rich source of protein, calcium, phosphorous and iron, and, contains high amounts of thiamine, riboflavin and niacin. It has long been a basic essential for underprivileged areas and amongst the unfortunate people (Mehra and Singh, 2017). A substantial quantity is used for other purposes such as poultry feed, cattle feed and alcohol withdrawal (Basavaraj et al., 2010).

Sorghum (Sorghum bicolor L.) is not suitable for warm and semi-arid areas of the world. Sorghum is containing high number of vitamins, minerals and carbohydrates (Nandini et al., 2001). Additionally, phenolic acid, anthocyanins, phytosterols, tannins which in phytochemicals (Awika and Rooney, 2004). The total area under sorghum in India is 7.76 million hectares with production of about 7.93 million tonnes (Mtelisi et al., 2020). Nutrients which are given above have a positive character to maintain the health and nutrition specially among the people who suffered from celiac disease, diabetes and obesity. Hence, it is a gluten free crop so their demand is increasing worldwide (Arendt and Dal Bello, 2011).

Sixth in terms of output worldwide, oat (Avena sativa L.) is grown on around 96,08,318 hectares of land, yielding 21.06 million tonnes (Food and Agriculture Organization, 2012). Oats are an annual plant and can be planted either in autumn (for late summer harvest) or in the spring (for early autumn harvest). Known locally as "jau", oats are grown on the foothills of Himalayas, such as in the India State of Himachal Pradesh. Oat groats are mostly composed of carbohydrates, namely starch (61 g/100 g), and soluble fibre (β-glucan), which ranges from 1.9 to 7.51 g/100 g (Bhatty, 1992). Oats include bioactive phytochemicals such vitamins, phenolic acids, and avenanthramides in addition to being a good source of soluble dietary fibre, β-glucan, and unsaturated fatty acids (Welch, 2011). According to Tiwari and Cummins (2009), β-glucan can be beneficial in lowering postprandial blood glucose levels and serum cholesterol concentration and it has been employed in a variety of food products to enhance the textural and rheologic features because it has good water requirement and emulsion stabilization properties.

This study aimed to investigate and compare the nutritional and physicochemical (i.e., PC, ash content (AC), fat content (FC), bulk density, swelling capacity) and other properties of pearl millet, sorghum and oat grown in India. A problem associated with low productivity and poor quality of Pearl Millet in dryland areas is the occurrence of micronutrient deficiency especially zinc which is because pearl millet is typically grown in drylands. Lowered absorption of the inorganic nutrients can result from interference in nutrient uptake and the unloading mechanism, and reduced transpirational flow. Among the micronutrients Zn deficiency is occurring in both crops and human (White and Zasoski 1999). Zinc is now considered as fourth most important yield-limiting nutrient after nitrogen, phosphorus and potassium (Maclean et al. 2002). Pearl Millet contains goitrogens, which can interfere with thyroid function by inhibiting iodine uptake, potentially leading to thyroid issues like goitre, especially in individuals with pre-existing thyroid disorders or iodine deficiency (Siroha et al., 2016). Sorghum is rich in manganese which is essential for thyroid hormone homeostasis and Oats are a good source of vitamins (B and E), minerals (zinc, copper, magnesium, manganese, and iron), and antioxidants, all of which are beneficial for various bodily functions, including thyroid health (Mushtaq et al., 2014). Pearl Millet chapatis have a greater thickness and a smaller diameter, but sorghum and oat flour provide chapatis with the required viscoelastic properties. It may be caused by an increase in the water-resistant kafirin proteins found in sorghum and oat flour (Bindu et al., 2007). Control sample (100% pearl millet) where lower water absorption is not desirable because it has been identified with quicker staling in chapati. This study aims to provides valuable information to increase scientific understanding of Indian grains for further food processing system to released nutritional products. On the basis of these nutritional parameters, gluten free chapati was made from dough of sorghum and oat with PM flour and evaluated for color, water activity and sensory acceptance. This information has helped in breeding better varieties well suited to the preparation of various food products. A knowledge of the relationship between the physical and chemical characteristics and the overall quality of the food products made from pearl millet would therefore be useful. The purpose of this paper is to report the relationships between certain physical and chemical characteristics and sensory quality of pearl millet cultivars.

2. REVIEW OF LITERATURE

Pearl millet is a nutritious cereal grown on about 10 million hectares in India, India is one of the largest producers of pearl millet. Besides providing food for human, millet stems are used for a wide range of purposes, including: the construction of hut walls, fences and thatches, and the production of brooms, mats, baskets, sunshades, etc (International Fund for Agricultural Development, 1999). Epidemiological evidence from research studies has indicated that diets rich in plant foods are protective against several degenerative diseases such as cancer, cardiovascular ailments, diabetes, metabolic syndrome, and Parkinson's disease (Manach et al., 2005; Scalbert et al., 2005; Chandrasekara and Shahidi, 2012). The proportion and chemical composition of sorghum's anatomical structures depend on the variety and growing conditions (Waniska & Rooney, 2000). The proportion of amylose and amylopectin affects the rheological proprieties (gelatinization, retrogradation, and gelling) and digestibility of the sorghum starch (Sang, et al., 2008; Singh, H., et al., 2010). Vitamin E activity is provided by the tocopherols and tocotrienols, which together create tocols. Alpha tocopherol is a major antioxidant component in crude oat unaltered when the lipid is refined, noted Zielinski et.al., 2001. Separate fatty acids (FA) also have different impact on human health. Many studies estimate the beneficial effects of polyunsaturated (PUFA) and monounsaturated fatty acids (MUFA), reported Chillard et al. (2000) and Gebauera et.al. (2005). Oats are a major component of infant foods due to their high nutritional profile, lack of allergenicity, palatable flavour, good shelf-life, stability and low cost. Food uses for oats include oat bran, oat meal, oat flour and oat flakes which are mainly used for breakfast cereals. Porridge, hot cereals, bread, biscuits, infant food, muesli and granola bars are a few examples of food products produced from oats. Oat flour is also used as a thickener in many infant foods, noted Ranhotra (1995).

Singh and Sehgal (2008) created two varieties of Ladoo using pearl millet grain that has undergone popping as a processing step. The created burst pearl millet Ladoo will also be examined for nutritional assessment in this paper. A substantial population that lives below the poverty line depends on pearl millet as a food source. Millet has comparable levels of fat, protein, and minerals to other cereals, but their application in different meal preparations is constrained by their uneven texture, absence of gluten, and traditional grain flavour. So, the grain of pearl millet was visible to cracking. Low bulk density and increased in vitro digestibility are the results of popping. From popped pearl millet, two varieties of Ladoo were prepared. To improve the nutritional value of the I kind, roasted and dehulled chickpea and peanuts were also included, whilst the II type of Ladoo was made using 100% popped pearl millet. According to the study, type I popped pearl millet Ladoo included perhaps higher amounts of calcium, phosphorus, and iron. Type I Ladoo also had higher levels of polyphenol and phytic acid and worse in vitro protein and starch digestibility. Type II Ladoo was found to contain more cellulose and lignin than type I Ladoo. There isn't much literature on pearl millet puffing, and little of the puffed grain is used in produce change. Additionally, there hasn't been much research on the nutritional assessment of popped pearl millet products. This study report offers a fresh approach for broadening the applications of this underutilised pearl millet to boost consumption.

Tanwar and Dhillon (2017) conducted research with the intention of creating and standardising gluten-free biscuits. In this study, the bajra flour (BF), buckwheat flour (BWF), and ragi flour (RF) mixture was used to create gluten-free cookies. By changing the ratio of flours, four experimental versions (gluten-free cookies) were produced. Utilising the 9-point hedonic scale and sensory research, the gluten-free cookie recipe was improved. Cookies samples were examined for their moisture, ash, crude fibre, total carbohydrate, total fat, and protein contents as part of the nutritional analysis. The mixture A3 with the flour ratios BWF 60g, RF 40g, and BF 100g had the best acceptance.

Puri was prepared for various Indian holidays by Gangle and Jadhao (2016). Because puri is a deep-fried food, it is mixed with soy bean and pearl millet flour in various concentrations. The nutritional value underwent significant adjustment. The 10 judges on the panel approved the "Puri" that was made using 20% pearl millet and 10% soya bean flour after conducting a sensory analysis. In a study, it was discovered that the concentration of hydration, carbohydrate, fat, and fibre content increased while the quantity of ash and protein fell as the percentage of pearl millet flour increased. However, it was discovered that the levels of water, ash, crude fat, fibre, and protein content rose while the amount of carbohydrates was lowered following the incorporation of soya bean flour. The finished product was subjected to guar gum treatments at concentrations of 0.25%, 0.50%, 0.75%, and 1% (w/w). The greatest oil approval ratio was obtained at 1% guar gum content.

Bagdi (2011) studied an impoverished farmer who was illiterate and had modest land holdings in the Maharashtra district of Nandurbar. His annual income was less than 5,000 rupees. The primary cuisine of the tribal farmers was sorghum chapati with urd dal (black gramme) or chatani (dry red chilli powder with salt), and they had big families with six to ten or more members. The tribal landowners were dispersed across the surrounding regions, working as workers in other farmers fields to supplement their income. Most tribal farmers had poor socioeconomic standing, meaning they lacked tools, equipment, irrigation systems, mechanical power, animal power, and material possessions. The tribal farmers relied heavily on the forest for wood to build their chapati and for cooking fuel and building materials, particularly for the roofs of their homes. Additionally, they were gathering Timbru leaves for the creation of Bidi for their personal smoking needs and Mahuda flowers from the forest for local use. The local tribal farmers in Maharashtra's Nandurbar district had a fair amount to little understanding of and access to various conservation of soil and water (SWC) technologies because of their precarious socioeconomic standing, which prevented them from approving expensive SWC solutions.

In the study by Kumari and Rajesh et al. (2015), the effect of flour, barley, and oats (Family Poaceae) on weight gain and associated metabolic disorders in obese human unpaid helpers was estimated. They received a daily dose of 150 g in the form of chapati for two months. Anthropometric, haematological, and specific limits tests were done on the participants at the start and the conclusion of the experiment. For two months, a single blind study was conducted. Both the Barley flour group and the Oat flour group showed significant improvements in their body weight, body mass index (BMI), basal metabolic rate (BMR), visceral fat, body fat, lipid outline, and skin fold depth; however, the Barley flour group was shown to be more efficient than the Oat flour group. Overweight human participants who consumed the flour from barley in a type of chapatis contributed demonstrated good effects on the weight of their bodies and a number of metabolic syndrome-related parameters.

The nutritional and medicinal profile of oats is functional. Oats soluble fibre and beta-glucan content can aid in the treatment of diabetes, cardiovascular disease, and obesity (Khanna and Mohan, 2017). Its physicochemical characteristics, including viscosity and molecular weight, which can be impacted by extraction techniques and gastrointestinal system behaviour, may be responsible for the health advantages.

According to Singh Gujral and Surinder Singh et al., 2008 study, the texture of wheat flour chapatis was evaluated using tensile distortion, and the degree of retrogradation was investigated using differential scanning calorimetry (DSC). The study also looked at the effects of conservative and partial baking and storage at two different temperatures (ambient and 18°C). After 24 hours of storage at room temperature and freezing, the normally baked chapati's extensibility fell by 58.7% and 20.15%, respectively. When stored in the same manner, the partially baked chapati experienced a substantially lower drop in extensibility and extensibility of 3.7% and 0.01%, respectively. In comparison to those held at 18°C, conservatively prepared and partially baked chapatis stored at room temperature displayed increased retrogradation enthalpy. While the extensibility of normally cooked chapatis proved unimportant, extended freezing storage of the partially baked chapatis resulted in a steady rise in extensibility. In slightly baked chapati held for 24 hours at room temperature, the lowest absorbance index of 4.60 was found, indicating that maximal the retrogradation process (4.19 J/g) had occurred. After thawing and rebaking, frozen partially cooked chapatis had a texture comparable to that of traditionally baked chapatis; as a result, they would be preferable than frozen normally baked chapatis for delaying staling.

3. MATERIALS AND METHODS

3.1 Materials

I purchased 2 kg each of sorghum, oat, and pearl millet grains from the local market shop in Hisar, Haryana (India) in February 2023. Grains were cleaned and debranned. After that they were milled and then flour was prepared. Airtight bags were used to store the sample.

3.2 Proximate composition

According to the standardised procedures outlined by the Association of Official Analytical Collaboration (AOAC), the moisture, crude protein, crude fat, ash, and crude fibre contents of pearl millet, sorghum, and oat flour were assessed.

3.2.1 Moisture (AOAC,1995)

Five grammes of ground sample were weighed in triplicate and dried to a uniform weight in a crucible in a hot air oven for seven to eight hours at 105 degrees Celsius. The dried product was as soon as possible moved to a desiccator, chilled, and weighed. According to the sample's weight loss, moisture was calculated.

Percentage moisture content was calculated below

$$\text{Moisture content}(\%) = \frac{(\text{initial weight} - \text{final weight})}{\text{weight of sample}} \times 100$$

Where; Initial weight = weight of dish + weight of sample before drying (g)

Final weight = weight of dish + weight of sample after drying (g)

3.2.2 Crude fat (AOAC,1995)

A cotton plug was placed inside the thimble after five grammes of the moisture-free sample were deposited there. Petroleum ether (40–60°C) was added in the flask, and thimbles were put in the beakers. The ether-dissolved fatty component was put to the beaker. Ether was finally expelled, and the remaining fat in the beakers was weighed. Using a Soxhlet assembly crude fat was extracted.

$$Fat\% = \frac{\text{W1} - \text{W2}}{W} \times 100$$

Where;

W1- is the weight of round bottom flask with residue

W2 - is the empty flask weight & W is the sample weight

3.2.3 Crude ash (AOAC,1993)

A pre-weighed plate was filled with the 5 g of moisture-free sample after it had been weighed. The sample was lit on fire and heated to 550°C in a muffle furnace for 4 hours. The following day, the desiccator was used to cool the crucible containing the residue before the crucible was weighed.

$$\%\text{Ash content } = \frac{weight\ of\ ash}{weight\ of\ sample}$$

3.2.4 Crude fibre (AOAC, 1993)

Using a Buchner funnel and a refluxer, samples were subjected to acid and alkaline treatment in order to quantify the amount of crude fibre.

$$\text{Crude fiber \%} = \frac{weight\ reduced\ on\ ignition\ (g)}{\text{Weight of sample (g)}} \times 100$$

3.3 Functional properties

The functional properties of flours were analysed i.e., and bulk density (g/cm3), swelling capacity (ml), water absorption capacity (WAC%).

3.3.1 Bulk density (Oladele and Aina, 2007)

The weight of flour is measured by its bulk density (Oladele and Aina, 2007). Bulk density provides a clue as to the necessary volume of packaging material. The properties of a treated product's container or package are determined by its density. A particular matte's mixing quality can be determined by its bulk density, which must be higher for flours to disperse more easily. Contrarily, preparing complementary foods would benefit from low bulk density (Basman et al., 2003). According to Jones et al. (2000), the obvious bulk density was determined using the weight and volume after measuring the volume of 10 g of flour in a cylinder of measurement (100 ml) after pressing the cylinder on a plank of wood until no discernible volume drop was noted.

3.3.2 Swelling capacity (Okaka and Potter ,1977)

The method outlined by Okaka and Potter (1977) was used to calculate the swelling capacity. The sample was poured into a 100 ml graduated cylinder to the 10 ml mark. 50 cc of water from distillation was added to make the final volume. The graded cylinder's top was tightly covered, then it was turned upside down to mix. After 2 minutes, the suspension was turned back around and left on its side for an additional 8 minutes. After the 8 minutes, the sample's volume was measured.

3.4 Preparation of Chapati:

The chapati was prepared from oats and sorghum blends in the ratios of 90:10,80:20 and 100% pearl millet, respectively. Salt was added 1% of the total proportion. Hot water (90–95°C) was added to 50g of flour, well combined, and manually kneaded until the desired consistency was achieved. The quantity of was estimated as ml needed for every 100g of flour in order to obtain the specified dough consistency. It was observed that the dough was shaped into a spherical shape with a consistent thickness. The roti was manually rolled out. Rolling quality was calculated as the largest diameter, in mm, to which the dough could be rolled before breaking. The flip during making roti, weight of raw roti, thickness of raw roti, baking pan temperature, baking time, flip during baking, thickness of roti after baking, weight of roti after baking was noted. Chapatis was evaluated for sensory qualities.

Table 3.1: Proportion of Chapati

Sr. No	Ingredients	Type A	Type B	Type C
1	Pearl millet	100	80	60
2	Oat (%)	0	10	20
3	Sorghum (%)	0	10	20

raw materials are weighed as need
↓
dry components are mixed together
↓
Water addition and kneading to create soft, malleable dough
↓
rounding and dividing into portions
↓
Bake using a flat baking pan

Fig.3.1 Flow diagram of preparation of chapati

3.5 Physical properties of chapati

With a small modification, the procedure outlined by Bala et al., 2015 was utilised to assess the chapati for the following categories of factors:

3.5.1 Weight (Bala et al., 2015)

With the support of a scientific weighting balance, the weight of the chapati was determined as the average values of the various types of chapatis. The weight's median amount was given in grammes.

3.5.2 Thickness (Bala et al., 2015)

Using a digital vernier calliper, the diameter of various chapati samples arranged edge to edge was measured to assess the thickness of the chapati. For each set of samples, an average of six values was taken. The average thickness value was given in mm.

3.5.3 Diameter (Bala et al., 2015)

Diameter of chapati was determined by placing two chapati samples edge to edge and measuring with a digital vernier calliper. An average of six values was taken for each set of samples. Average value for diameter was reported in mm.

3.5.4 Spread ratio (Bala et al., 2015)

The spread ratio was obtained by finding the ratio between the average width and thickness of the chapati. It gave an indicator of chapati quality.

Spread ratio = Diameter / Thickness

3.5.5 Texture analysis (Cheng et al., 2015)

Using a texture analyzer, the chapati's textural characteristics were measured. The parameters used were trigger type = auto, pre-test speed = 5.0 mm/sec, test speed = 2.0 mm/sec, post-test speed = 10.00 mm/sec, distance = 10.00 mm/sec. The middle of each chapati was used to cut four 2 x 2 cm chapati strips. The two clamps were holding a chapati strip in the middle. The platform was secured with one clamp, and the texture analyser's moving arm was secured with the other. The chapati strip was pulled apart by the clamps until it ruptured. According to Cheng et al. (2015), the maximum force (N) needed to separate the chapati strip into two pieces was measured.

3.5.6 Color analysis (Panghal et al., 2019)

All Chapati samples had their colours analysed using a chromometer in accordance with the process outlined by Panghal, Khatkar, Yadav, and Chikara (2019). Each Chapati sample was placed below the chromometer's colour sensor, where readings of "l," "a," and "b" were recorded. L*, a*, and b*, respectively, indicated the colour transitions from black to white, green to red, and blue to the sample's yellow hue. L* values were calculated using a scale of 0 (black) to 100 (white), whereas other values were calculated using a scale of 0 to 60 shades correspondingly.

3.6 Sensory evaluation

A sensory panel of ten judges- seven girl and three boys, ranging in age from 22 to 26 years-evaluated the chapati using a 9-point hedonic scale to assess their colour, look, texture, flavour, and overall acceptability. The samples were evaluated based on a 9-point hedonic scale with 1 representing the least score (dislike extremely) and 9 as the highest score (like extremely). The panellists were instructed to rinse their mouth thoroughly with potable water in between samples evaluations and they were requested to taste the chapati samples one by one.

4. RESULTS

4.1 Physio-chemical characteristics

The result of proximate composition of different grains is below.

Table 4.1 Proximate composition of Pearl millet, Sorghum and Oat

Flours	Moisture	Ash	Fat	Crude fibre	Bulk density(g/ml)	Swelling capacity (%)
Pearl millet	11.6%	16.2%	5.8%	2.4%	0.521	0.07
Sorghum	10.38%	1.98%	8.96%	1.39%	0.5	1.27
Oats	7.50%	1.69%	1.16%	96.09%	0.399	1.34

4.2 Physical characterization of Chapati

The chapati prepared from pearl millet flour with sorghum and oats flour incorporation were analysed for their physical properties and results are shown in Table 4.2 below. The weight of the chapati ranged 93 – 113 g with the highest value in the sample with 20% sorghum and oats flour and the lowest was observed for control sample. The spread ratio of the chapati decreased with increase in amount of sorghum and oats flour as the values for both diameter decreased and thickness increased with increasing amount of sorghum and oats flour and ranged from 3.11- 3.68 mm.

Table 4.2 By 100% pearl millet

Process	60g flour	70g flour
1% Salt	0.6 g	0.7 g
Water	47 ml	51 ml
Flip before baking	52 times	72 times
Weight of raw roti before baking	109.49 g	125.62 g
Thickness of raw roti before baking	3.11 mm	3.16 mm
Diameter	5.7 inch	5.78 inch
Spread ratio	1.83	1.82
Baking pan temperature	307.5℃	279.16℃

Flip during baking	13 times	19 times
Baking time	2 min. 57 sec.	3 min. 16 sec.
Weight of roti after bake	93.31 g	101.45 g
Thickness of roti after bake	3.27 mm	3.3 mm

Table 4.3 By PM +OF10%+SF10%

Process	**60g flour**	**70g flour**
1% Salt	0.6 g	0.7 g
Water	52 ml	56 ml
Flip before baking	62 times	67 times
Weight of raw roti before baking	102.36 g	106.47g
Thickness of raw roti before baking	3.65 mm	3.67 mm
Diameter	5.58 inch	5.62 inch
Spread ratio	1.52	1.53
Baking pan temperature	268.6℃	272.3℃
Flip during baking	16 times	18 times
Baking time	3 min 12 sec	3 min 27 sec
Weight of roti after bake	96.22 g	98.54 g
Thickness of roti after bake	3.78 mm	3.82 mm

Table 4.4 By PM +OF20%+SF20%

Process	**60g flour**	**70g flour**
1% Salt	0.6 g	0.7 g
Water	51 ml	57 ml
Flip before baking	62 times	65 times
Weight of raw roti before baking	109.2 g	124.23g
Thickness of raw roti before baking	3.68 mm	3.70 mm
Diameter	5.4 inch	5.61 inch
Spread ratio	1.46	1.51
Baking pan temperature	264.13℃	270.34℃
Flip during baking	14 times	17 times
Baking time	3 min. 16 sec.	3 min. 34 sec.
Weight of roti after bake	101.3 g	113.56 g
Thickness of roti after bake	3.81 mm	3.84 mm

4.3 Color Analysis of chapati

The results obtained are shown in table 4.5.

Table 4.5 Color analysis of chapati

Sample	L*	a*	b*
Color of control	51.78	7.74	15.96
Color of 10%(OF+SF)	51.26	9.40	16.77
Color of 20%(OF+SF)	50.38	9.45	16.37

4.4 Texture Analysis of chapati

A texture analyser was used to analyse the texture of standardized pearl millet chapati, and the force ratio is presented in the table form and also graphical representation below.

Table 4.6 Texture analysis of chapati

Sample	**F1**	**F2**	**F3**
Color of control	2.48	2.74	2.84
Color of 10%(OF+SF)	2.56	3.66	3.75
Color of 20%(OF+SF)	2.97	3.42	4.34

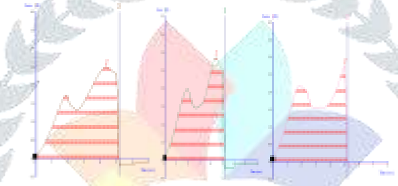

Fig.4.1 Graph for Control sample

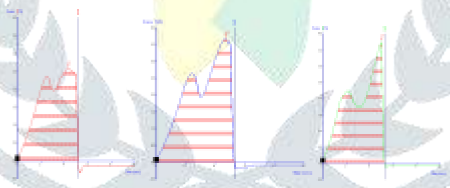

Fig.4.2 Graph for 10%(sorghum+oat) incorporated pearlmillet chapati

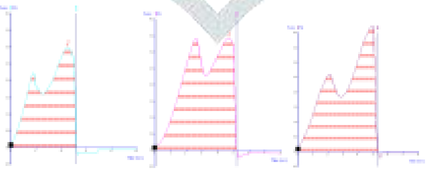

Fig.4.3 Graph for 20%(Sorghum+oat) incorporated pearlmillet chapati

4.5 Sensory Analysis

The sensory analysis that I conducted with the department Professors, the results are listed in the table 4.7 below

Table 4.7 Sensory evaluation of chapati

Sample	Shape	Color	Texture	Taste	Overall acceptance
PMF	7	8.0	6	8	7.5
SF+OF 10%	7.5	8.0	6.4	7.8	8
SF+OF 20%	7.8	7.8	7	8	7.7

PMF: Pearl millet flour

SF: Sorghum flour, **OF:** Oat flour

PMF+ SF 10% + OF 10 %: Pearl millet flour incorporated with 10% sorghum and oat flour

PMF+ SF 20% +OF 20%: Pearl millet flour incorporated with 20% sorghum and oat flour

5. DISCUSSION

5.1 Physio-chemical characteristics

The chapati quality of pearl millet was influenced by the physicochemical characteristics of grain. The proximate analysis of the pearl millet flour revealed that the flour has 11.6% moisture content, 5.8% fat, 2.4% crude fibre, and 16.2% ash. Similar results were reported by (Siroha et. al., 2016) which shows proximate composition of various varieties of pearl millet which was 10.23 to 11.67 % moisture content, 5.1 to 7.2 % fat, 2.9 to 3.8 % crude fibre, and 1.65 to 1.90 %ash. The proximate analysis of the sorghum flour revealed that the flour has 10.38% moisture content, 8.96% fat, 1.39% crude fibre, and 1.98% ash. Similar results were shown by (Jimoh et. al., 2017) which was 9.75-16.32 % moisture content, 5.1 to 7.2 % fat, 2.79 % crude fibre, and 1.12-1.68 %ash. Oat flour composition was approximately similar to the composition given by (Hussaini et. al., 2022) which shows 5.23% moisture, 2.4% ash, 3.2% fat. Bulk density of various flour formulations was found to be in the range of 0.339-0.53 g/cm3. It is clear that decreased proportion of pearl millet flour, decrease the bulk density of composite flours. Similar results were reported by various researchers (Chandra et al., 2013, Bamigbola et al., 2016 & Tangariya et al.,2018) which shows range of bulk density from 0.39 to 1.24. Bulk density is generally affected by the particle size and the density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry (Tangariya et al., 2018). Swelling capacity (index) is considered a quality measure in some food products such as bakery products. It might be due to dietary fibre improves mixing sensitivity and water absorption due to the hydroxyl groups in the fibre structure, which promote stronger hydrogen bonding between water molecules. Compared to other cereals, oat starch absorbs more water because the gelatinization of starches was believed to be the source of the higher water absorption index. Similar results were reported by Chandra et al. (2013) during a study on functional properties of composite flour made by blending rice flour, green gram flour and potato flour with wheat flour.

5.2 Effect of Oat and Sorghum flour on characterization for preparation of chapati

On water required- It was noticed that water absorption capacity of flour increased with increase the value of oat and sorghum flour in pearl millet flour during dough development for chapati making process. For control sample (100% pearl millet) water absorption capacity was 47 ml to 51 ml for 60 g and 70 g flour respectively but, it increased with addition of oat and sorghum flour value in pearl millet flour from 52 ml to 56 ml in 10 % incorporation and in 20 % incorporation it was 51 ml to 57 ml which shown the increased value of water required for dough development. Due to the increased water absorption as well as retention capacities of oat and sorghum flour, the chapati had a higher level of moisture. By adding more protein to composite flours, the starch was diluted, and the rate of preservation was slowed. Oat flour significantly changed the rheological characteristics of dough. Oat β-glucan was crucial in boosting chapati moisture and water absorption. In general, dietary fibre improves mixing sensitivity and water absorption due to the hydroxyl groups in the fibre structure, which promote stronger hydrogen bonding between water molecules (Sharma et. al., 2017). As the amount of oat flour boosted dough stability dropped while dough time for growth increased. The increased retention of water and larger size of particles of oat flours may be the cause of the lengthier dough formation time (Mtelisi et. al., 2020).

On baking time- Baking time of pearl millet chapati increased with increasing incorporation of oat and sorghum value. For control sample (100% pearl millet chapati) baked time was 2 min. 57 sec. for 60g flour sample and 3 min. 16 sec. for 70g sample. After mixture of oat and sorghum flour, it was increased 3 min. 12 sec. for 60 g and 3 min. 27 sec. for 70g flour sample chapati which was incorporated with 10% oat and sorghum flour. And baked time for pearl millet chapatti which was incorporated with 20% oat and sorghum flour that was 3 min. 16sec. and 3 min. 34 sec. for 60g and 70g flour chapati respectively. The enhanced capacity of the starch granules to soak up water may be the cause of the increase in thickness of the sorghum and oat flour as the period of processing by heat extended. The chapati's ability can be made better as a result of the longer baking time. And it might also be because the heat treatment increased the number of crumb cells within a certain area and heat-treated flour significantly increased the fineness of crumb grain (Flander et. al., 2007).

On percentage of loss of moisture during baking- It was observed that percentage of moisture loss of control sample chapati (100% pearl millet) was 14.77% during baking and after incorporation of oat and sorghum flour it was decreased up to 5.99%. It might be because oat and sorghum flours were heated being used to make compound and free gluten chapati, as well as because more fibre has a higher capacity to absorb water. It demonstrates that as oat and sorghum levels were increased, the moisture content of chapati increased as well. Because oxidation in this case increased the disulphide cross-linkages of amino acids and as a result produced a stronger dough that had more durability against impact and a larger dough volume, these effects had also been associated to the alterations of free sulfhydryl groups of proteins (Mtelisi et. al., 2020).

On sheeting characteristic- There was significantly increase in thickness of pearl millet chapati and decrease in diameter. Thickness of raw chapati ranged from 3.11mm in control to 3.65mm in 10% incorporation of oat and sorghum in Pearl millet chapati and after baked it was 3.27 mm to 3.78 mm respectively. It may be caused by an increase in the water-resistant kafirin proteins found in sorghum and oat flour, which are ineffective in providing the dough with the required viscoelastic properties. Additionally, this increase in particular thickness may be caused by the oxidation of the free sulfhydryl groups, which modifies the proteins in sorghum flour (Wang et. al., 2017). Similar to this, the circumference of pearl millet chapati shrank with increasing oat and sorghum flour absorption. With increased oat and sorghum flour absorption in pearl millet chapati, it was found that there was higher breakage. It might be because there is less gluten in the chapati, which causes less binding and more chapati breakdown.

5.3 Color Analysis of chapati

The replacement up to 20% of millet flour to the chapati formulation culminated in such a dark inner and outer chapati colour. There was a decrease in L* value due to addition of oat and sorghum flour in pearl Millet chapati because they are responsible for loss of flour brightness. It was reported that with an increase in protein content there is a decrease in L value. Addition of oats flour also decrease b* value, probably due to oat bran color in the flour. In contrast, addition of sorghum flour in pearl Millet chapati increase the b* value because its content higher value of protein and dietary fibre. Apart from that, the redness of the chapati was not changed with the addition of oat flour due to particle size which was larger than pearl Millet flour. But addition of sorghum flour was increasing a* value of chapati. Its particle size was fine rather than pearl Millet flour. In the chapatis significant differences was observed for all L, a, b values.

5.4 Texture Analysis of chapati

The cutting force of chapati is important textural properties of chapatis. The average peak force is measure of chapati hardness. An increasing force was observed for cutting force of chapatis prepared from pearl Millet flour and incorporated with sorghum and oat flour. Cutting force reflect the texture of the chapati and biting action of the human teeth on chapati. The cutting force for peal Millete chapati were ranging from 2.48 to 2.84 N. The cutting force for chapatis made from 10% and 20% incorporation of sorghum and oat flour were between 2.56 to 3.75 N and 2.97 to 4.34 N respectively. I was checking this force after 5 to 7 minutes to made chapati. Oat and sorghum flour were added, which resulted in being enriched in more proteins, increasing the cutting force. Approximately similar results were found by (Gujral and Pathak, 2002). The study found that the compound chapati's the degree of hardness, consistency, springiness, chewiness, and gumminess were all increased by the use of sorghum flour. The sensory scores for chapati's softness and tongue feel were substantially reduced as sorghum flour content was raised in chapati. The poor gluten-starch structure that resulted from the proportionate decline in starch stability was linked to how hard the chapatis would be. Therefore, a loss in the structural strength of the sorghum starch granules after baking may be related to an increase in the hardness of sorghum combined chapati. The brittleness of the chapati was reduced by increasing the oat flour content (Mtelisi et. al., 2020). This is possibly because oats have more fat than sorghum and pearl millet. In chapati, fats function as an adhesive and have soothing characteristics.

5.5 Sensory Analysis

Research findings from a study on the influence of flour mixes on the quality of gluten-free chapati indicated that a mixture containing 10% sorghum and oat flour was one among the three best mixtures selected based on sensory data. This shows that incorporation of these flours could exert beneficial influence on the quality of chapati. The scores for flavour of the chapati decreased with the level of sorghum flour in the chapati. The decrease in the flavour of the chapati was due to the loss of the volatile flavour compounds in the sorghum flour during baking processes. A point to be noted here is that there was a wide variation in the composition and relative proportion of ingredients of the products studied, which, in all probability, resulted in the diverse quality of the products. In the present study, control chapati had darkened color and crisper and harder texture. Desirable attributes such as aroma and taste were low in this sample that consequently reduced its overall quality. On the other hand, with 10 % sorghum and oat chapati had closely matched sensory profile which differed significantly from control in key attributes such as color, aroma and little bit bitter taste. Higher perceived intensities of these desirable sensory parameters significantly and positively impacted the overall quality of pearl millet chapati rated at 8 for 10% SF (Sorghum Flour) and OF (Oats Flour) and 7.7 for 20% SF and OF in pearl millet chapati respectively as compared to control. These finding indicated that the pearl millet chapati with incorporation acceptable as indicated by their higher overall quality score compared to control. However, in the present study, it was found that dark color of the pearl millet chapati did not adversely affect the acceptability of the samples. Instead, it provided an interesting visual appeal.

5.6 Storage stability

I took samples which I kept in different condition. Out of which I put one in deep freezer and second at room temperature. This process was done for 2 days. Samples were packed in high-density polyethylene (HDPE) pouches. After that I noted the results. Moisture content has important role in determining storage life of chapati. Lower the moisture content, longer is storage stability. Control sample (100% pearl millet) where lower water absorption is not desirable because it has been identified with quicker staling in chapati. But moisture of chapati sample increased significantly during storage period at room temperature 30-35°C within 2 days of storage of chapati which make chapati undesirable.10% to 20% of oat flour incorporation preferred but less stability. If we increase their quantity, it gives food in preservation a bitter taste and also renders chapati soft, which boosts the chapati's ability to absorb moisture thanks to lipase. Incorrectly prepared chapati's flavour inconsistency may be brought on by native oat catalysts. If not destroyed during processing, oat lipase activity is high enough to break down lipids in oat and generate an unpleasant soapy flavour. There are two ways that lipoxygenase can affect flavour quality. First off, the enzyme can result in the generation of volatile aldehydes and ketones due to the high polyunsaturated fatty acids (PUFA) concentration in oat oil. Enzymes can also oxidise lipids, producing bitter non-volatile substances as a result. The production of particular hydromonoglycerids has been linked to the bitterness in chapati that has been preserved (Meera et. al., 2011). Another was placed in a 4°C freezer. Due to less water absorption, I discovered that controlled chapati rigidity rose during the course of the controlled sample. Contrarily, integrated chapati contained a significant amount of water, making it more stable over time. Due to the adhesiveness, gumminess, and cohesiveness qualities of sorghum flour, chapati stiffened over time. The chapati's colour and flavour were both impacted, making them slightly more bitter than before. There are many fatty acids in sorghum, and lipoxidation caused by lipases results in free fatty acids, of which polyunsaturated ones are subsequently oxidised and cause flavour instability (Mtelisi et. al., 2020). Changes in free fatty acids throughout preservation caused by lipase action also affect the properties of chapati.

CONCLUSION

Composite pearl millet-based flours were formulated with sorghum and oat and evaluated for the physicochemical, rheological and chapati making properties. All the chemical parameters were found to be suitable with the flour and chapati making properties. The results showed that the chapati with 10% incorporation of sorghum and oat considered the best as compared to the other composite chapati samples. The results have shown that chapati with higher percentage of sorghum and oat had low sensory acceptability except for levels of 10% and 20% because incorporation of high quality had produced bitter taste and enzymes cause flavour instability whereas, in oats lipase activity was high due to soapy taste. The storage studies of the chapati samples with packed in high-density polyethylene (HDPE) pouches were carried out at 4°C for 2 days. Results of study will eventually benefit consumers as well as able to extend commercial opportunity for chapati manufacturer. The traditional products like chapatis can be preserved for long term storage, increasing their commercial scope and viability.

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