DEVELOPMENT AND STANDERDIZATION OF FIBER AND PROTEIN ENRICHED MULTI GRAIN COOKIES

(Wheat, Barley, Finger millet flours)

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Abstract: A study was undertaken to explore the possibility of Barley flour and finger millet flour as a fortification of fiber and protein in food. Wheat flour being one of the most commonly used bases for popular meal products, an attempt was made to enrich wheat flour with fiber and protein through processed barley and finger millet flour. As the study indicated, the best acceptable process method was obtained at the barley and finger millet flour. The protein and fiber enriched cookies were developed in the different proportions wheat flour: barley: finger millet, varying in different samples namely S 1; 80:10:10, S 2; 60:10:30, S 3; 60:20:20 and for control sample C S; 60:0:40 in, (g) about 100 g of sample flours. Overall study confirms that suitably processed barley and finger millet flours could be the best biological source of protein and fiber supplement through daily foods to meet the daily protein and fiber requirements.

Keywords: Cookies, Fiber, Protein, Barley, Finger Millet, Fortification.

I. INTRODUCTION

Cookies are widely consumed throughout the world. It is different from other baked products like bread and cakes because of their low moisture content which ensures that are free from microbial spoilage and a longer shelf life on the product (Poonam Dhankar, 2013). The longer shelf life of cookies makes large scale production and distribution possible. Cookies are generally used as snacks by irrespective of all age group. Cookies are usually made up of wheat flour and production of cookies from wheat flour is deficient in several nutrients including some vitamins, mineral elements, proteins as well as dietary fibers (vasan alka, 2017). Which helps in the reducing cholesterol, heart diseases and causes low obesity levels (NIDDK, 2008). Till now there are some products like (Cookies, Biscuits, and Breads) which are fortified with finger millet flour for dietary fiber, protein, carbohydrates and other minerals such as potassium, Fe, Zn etc, and having good anti - oxidant properties (Sudhakar kokate, 2014). Which helps in the, these have been developed by the addition of barley flour as it consists of high soluble fiber, 10% protein, carbohydrates and vitamin complexes, E. and helps in to reduce the blood cholesterol level, lowers blood glucose and risks of breast cancer (Sudhakar kokate, 2014). and at the particular ranges blended with different kinds of flour in order to increase the intake of fibers and proteins. barley flours are rich in dietary fiber and protein which aids to lower the cholesterol level in the body. Whereas, finger millets are also rich in dietary fiber, protein and also it is rich in calcium (D.S. Ikuomola *et al.,* 2017). Therefore, the addition of these two ingredients in the cookies provide high dietary fiber and also calcium, protein. By considering all these health benefits the present investigation was carried out with an objective to standardized the methodology (AOAC. 1995) for the preparation of fiber, protein enriched cookies and evaluation of nutritional, physical and sensory attributes of cookies and also to access barley and finger millet as main bakery ingredient by combining with wheat flour and developing of the cookies.

II. MATERIALS AND METHODS

2.1 Procurement of samples

The raw material required for the development of product such as, wheat flour, barley flour, finger millet flour, salt, sugar, baking powder, butter, vanilla essence and skim milk powder were procured from the local market in Guntur and Old Guntur market, Andhra Pradesh.

III. PREPARATION OF FORTIFIED WHEAT FLOUR

The fortified wheat flour was prepared by adding finger millet flour; S 1(10g); S 2(10g); S 3(20g) and barley flour; S 1(10g); S 2(30g); S 3(20g) to S 1(80g); S 2(60g); S 3(60g) of wheat flour. The flour is then sieved to get homogeneous mixture. And the final mixture was used to develop the cookies.
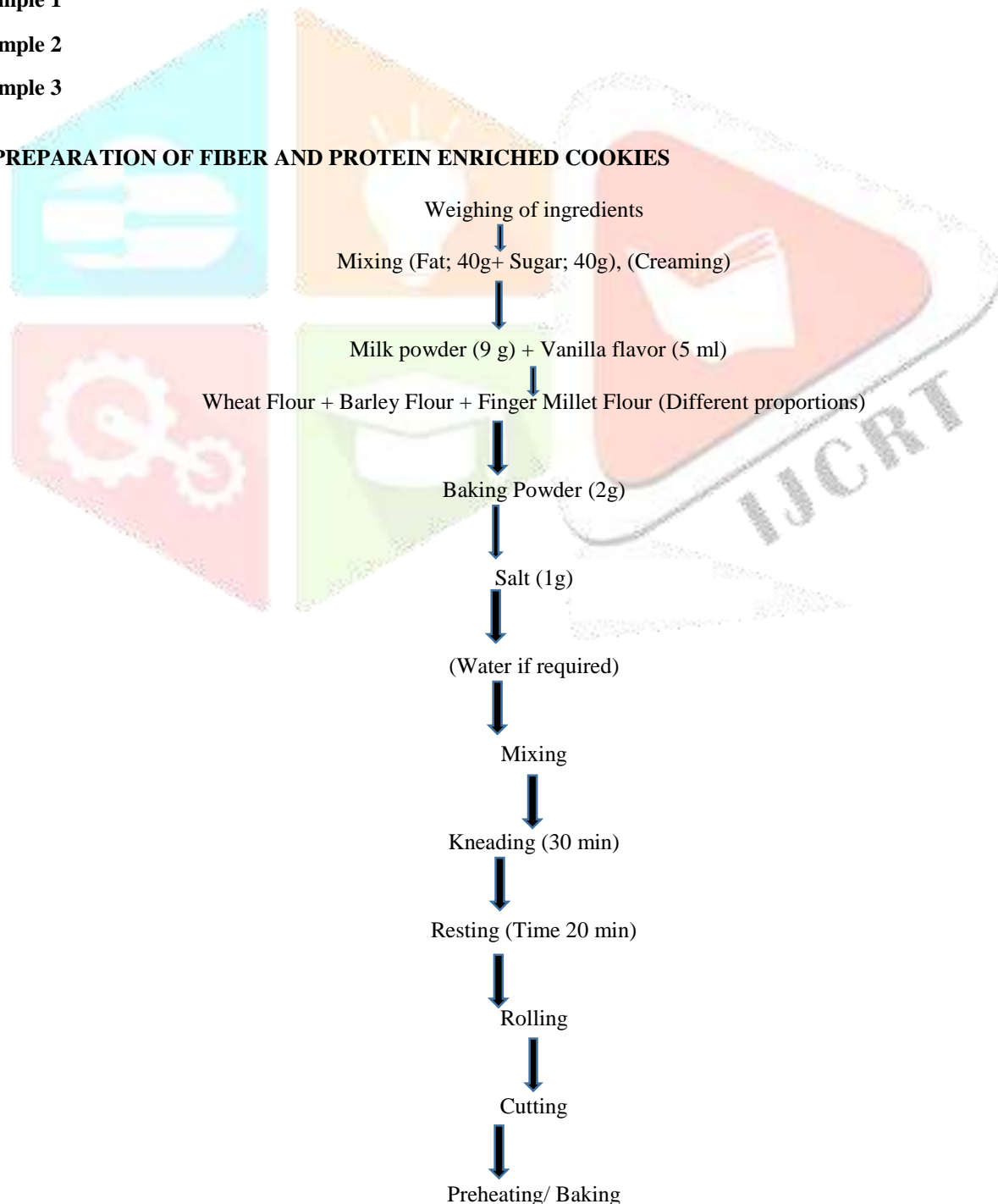
Parameters	Control sample *(CS)	Fortified *(S 1)	Fortified *(S 2)	Fortified *(S 3)
Wheat flour (g)	60	80	60	60
Barley flour (g)	-	10	30	20
Finger millet flour (g)	40	10	10	20

*S 1 – Sample 1

*S 2 – Sample 2

*S 3 – Sample 3

IV. PREPARATION OF FIBER AND PROTEIN ENRICHED COOKIES

Weighing of ingredients

↓

Mixing (Fat; 40g+ Sugar; 40g), (Creaming)

↓

Milk powder (9 g) + Vanilla flavor (5 ml)

Wheat Flour + Barley Flour + Finger Millet Flour (Different proportions)

↓

Baking Powder (2g)

↓

Salt (1g)

↓

(Water if required)

↓

Mixing

↓

Kneading (30 min)

↓

Resting (Time 20 min)

↓

Rolling

↓

Cutting

↓

Preheating/ Baking

(180℃/ 10 min)/ (180℃ / 25 min)

Cooling

Cookies

Weighing and Packing

- Weight of flours before mixing, (g)
- Weight after mixing, (g)
- Weight after baking, (g)
- Amount of yield obtained, (g)

V. COMPOSITION OF DEVELOPED FIBER AND PROTEIN ENRICHED COOKIES - MULTI GRAINS

Parameters	Control Sample *(C S)	Fortified *(S 1)	Fortified *(S 2)	Fortified *(S 3)
Wheat flour (g)	60	80	60	60
Barley flour (g)	-	10	30	20
Finger millet flour (g)	40	10	10	20
Salt (g)	1	1	1	1
Sugar (g)	40	40	40	40
Butter (g)	40	40	40	40
Skim milk powder (g)	7.5	9	9	9
Baking powder (g)	2	2	2	2
Vanilla essence (ml)	5	5	5	5

*S 1 - Sample 1

*S 2 - Sample 2

*S 3 - Sample 3

VI. ESTIMATION OF CHEMICAL PROPERTIES

6.1 Estimation of Moisture content

Moisture content was estimated by using AOAC method (1995).

Finely ground sample (2g) was weighed accurately in a covered dish previously dried at 98° - 100°C, cooled in desiccator and weighed soon after reaching room temperature. Loosen cover and heated at 110°C in hot air oven for 2 hours. Immediately tightened the cover on dish, transferred to desiccator and weighed soon, after reaching room temperature. The resultant loss in weight was calculated as percentage moisture content on dry basis (A.O.A.C. 1995).

Moisture% = [($W_1 - W_2$)× 100] ÷W

W = Weight of sample

W_1 = Weight of sample + Weight of Petri Dish

W_2 = Weight of dried sample + weight of petri Dish

6.2 Estimation of Ash content (%)
Ash was estimated by using standard method of AOAC (1995).

5 gm sample was weighed and transferred in pre-weighed porcelain crucible. The weighed sample was charred till smoke ceases. The crucible was then transferred to muffle furnace maintained at 550^0C and incinerated until light grey ash was obtained (nearly for 5 or 6 hours). The crucible was then cooled in desiccator and weighed. The results were reported on dry weight basis.

Ash% = [($W_1 - W_2$) ×100] ÷ W

W = Weight of sample

W1 = weight of sample + weight of crucible.

W2 = Weight of ash + weight of petri dish (after ash)

6.3 Estimation of Crude fat content
Crude fat was estimated using standard method of AOAC (1995).

A ground 5 g sample was weighed accurately and transferred to the thimble and defatted with petroleum ether in Soxhlet apparatus for 6-8 hours at 80°C. The residue was procured and ether is removed by evaporation. The loss in weight of thimble was estimated as loss of lipids from sample and expressed as per cent lipids in sample.

Fat % = [loss in weight of sample × 100] ÷ weight of sample

6.4 Estimation of Protein content

Crude protein content was estimated according to the Kjeldahl method as described in AACC (2000) method No. 46-10.

Two grams sample was weighed and put into the digestion tube. Twenty milliliters of concentrated sulphuric acid (98%) and 2 tablets of digestion mixture as catalyst were added into the digestion tube. The digestion was carried out for 3-4 h (till the digested contents attained transparent color). The digested material was allowed to cool at room temperature and diluted to a final volume of 50 ml. The ammonia trapped in H_2SO_4 was liberated by adding 40% NaOH solution through distillation and collected in a flask containing 4% boric acid solution, possessing methyl indicator and titrated against standard 0.1 N H_2SO_4 solution. The factors 6.25 and 5.70 were used for the conversion of percent nitrogen into crude protein contents of composite flours and wheat flours, respectively.

6.5 Estimation of crude fiber content

The crude fiber was estimated according to the procedure as outlined in AACC (2000) method No. 3210.

It was carried out by taking 3 g of each fat free sample and digested first with 1.25% H_2SO_4, washed with distilled water and filtered, then again digested with 1.25% NaOH solution, washed with distilled water and filtered. Then ignited the sample residue by placing the digested samples in a muffle furnace maintained for 3-5 hours at temperature of 550-650 °C till grey or white ash was obtained.

The percentage of crude fiber was calculated after igniting the samples according to the expression given below.

$$\text{Crude fiber (\%)} = \frac{Weight\ loss\ in\ ignition}{Weight\ of\ the\ sample} \times 100$$

6.6 Estimation of Carbohydrate content

Carbohydrate content was calculated for cookies by difference method AOAC (1995) on dry using following formula:

Total carbohydrate = 100 – (fat + fiber + ash + protein).

VII.   ESTIMATION OF PHYSICAL PROPERTIES

7.1 Estimation of weight

The weight of the cookies was determined according to the method of Ayo, Ayo, Nkama and Adeworie (2017) The weights of cookies samples were determined with the aid of a weighing balance immediately after cooling.

7.2 Diameter of cookies

For the determination of the diameter, six cookies were placed edge to edge. The total diameter of the six cookies was measured in mm by using a ruler. The cookies were rotated at an angle of 90^0 for duplicate reading. This was repeated once more and average diameter was reported in millimeters (AACC, 2000).

7.3 Thickness of cookies

To determine the thickness, six cookies were placed on top of one another. The total height was measured in millimeters with a ruler. The measurement was repeated thrice to get an average value and results were reported in mm (AACC, 2000).

7.4 Spread ratio of cookies

Spread ratio was calculated as diameter (length) to thickness ratio (Shrestha and Noomhorm, 2002).

Spread ratio   =   Diameter / Thickness

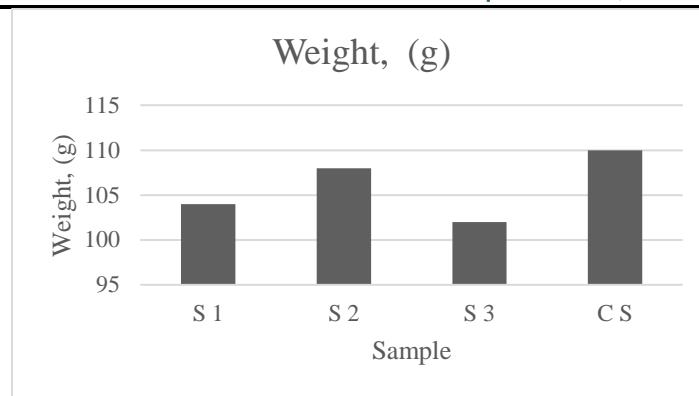## VIII.   SENSORY EVALUATION OF THE FIBER ENRICHED COOKIES

The product cookies were evaluated for sensory characteristics on 9-point Hedonic scale by panelist (9 – Like extremely, 8 – Like very much, 7 – Like moderately, 6 – Like slightly, 5 – Neither like nor dislike, 4 – Dislike slightly, 3 – Dislike moderately, 2 – Dislike very much, 1 - Dislike extremely). The samples were evaluated for Color, Appearance, Taste, Texture, Chewing ability and Overall acceptability.

IX.   RESULT AND DISCUSSION
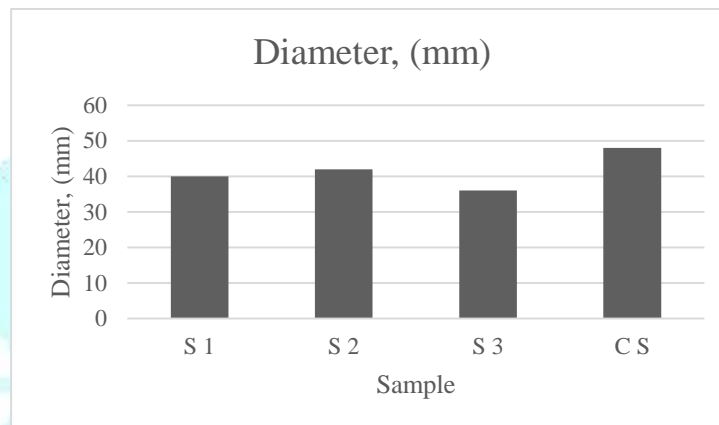## X.   PHYSICAL PROPERTIES OF COOKIES

10.1 Weight of cookies (g)

The weight of the cookies from Control sample*C S (110g) was heaviest and bulkiest when compared to the Fortified *S 1; (104g), Fortified *S 2; (108g) and Fortified *S 3; (102g). The significant reduction in the weight of cookies produced from barley and finger millet (Alobo, 2001) supplemented with wheat flour (Ayo et al., 2007) respectively.
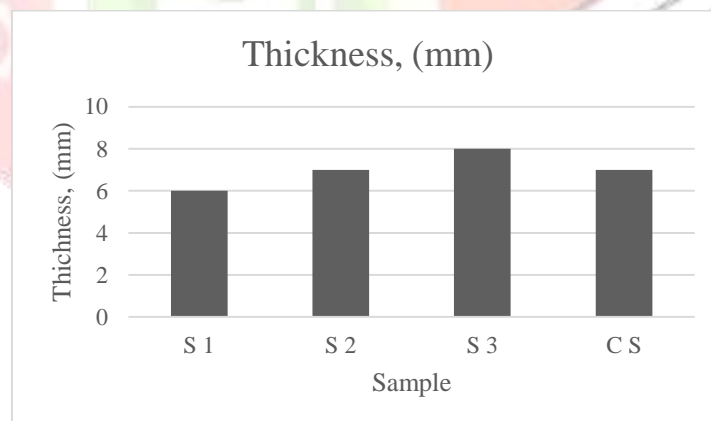
Weight, (g)

10.2 Diameter of Cookies (mm)

Diameter of cookies control sample were*C S; (48mm) were significantly increased when compared to the Fortified *S 1; (40mm), Fortified *S 2; (42mm), Fortified *S 3; (36mm). This could be attributed to the amount of fat added to the flour blends during production. Ikuomola *et al.,* (2017)
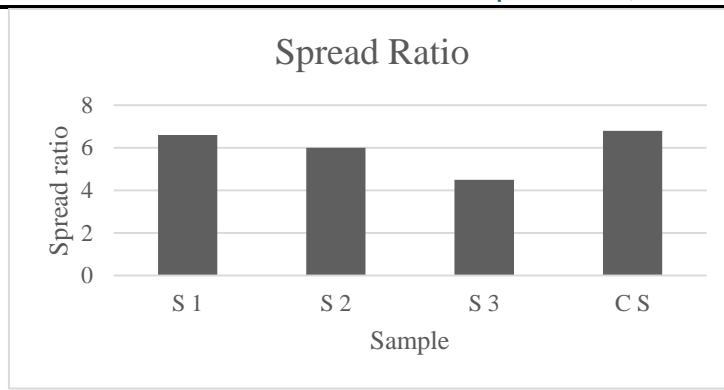
Diameter, (mm)

10.3 Thickness of the cookies (mm)

The thickness of the cookies ranged from Control sample *C S; (7mm), Fortified sample *S 1; (6mm), Fortified sample *S 2; (7mm), and have been increased in Fortified sample *S 3; (8mm). The thickness of the cookies was significantly increased with increasing in the quantities of the barley and high proportions of the finger millet flours Ikuomola *et al.,* (2017). As the increase in thickness also resembles that increase in the absorption of moisture content Abdul *et al.,* (2015)

Thickness, (mm)

10.4 Spread ratio of cookies

The spread ratio of the cookies ranged between 4.5 – 6.8; where Control sample *C S; 6.8 ha the highest spread ratio (6.8), when compared to the Fortified cookies*S 1 (6.6), Fortified cookies *S 2; (6), Fortified Cookies *S 3; (4.5). The addition of barley and finger millet flours to the wheat caused significant decrease in level when compared to that of the Fortified samples Giwa and Ablodun, (2010).

XI. WEIGHT OF FIBER AND PROTEIN ENRICHED COOKIES

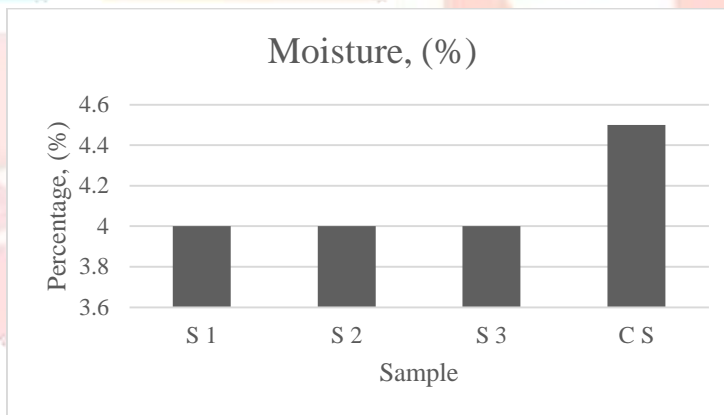| Parameter	Fortified *S 1 (80:10:10)	Fortified *S 2 (60:10:30)	Fortified *S 3 (60:20:20)	Control sample *C S (60:40)
Weight (g)	104	108	102	110

XII. PHYSICAL PARAMETERS OF FIBER AND PROTEIN ENRICHED MULTI GRAIN COOKIES

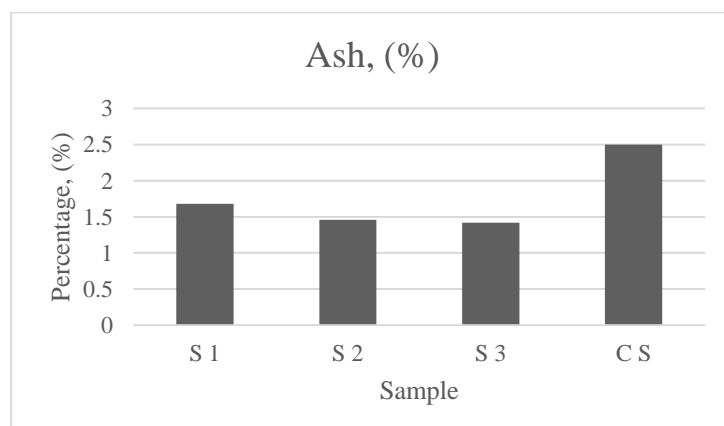| Parameters	S 1 (80:10:10)	S 2 (60:10:30)	S 3 (60:20:20)	C S (60:40)
Diameter (mm)	40	42	36	48
Thickness (mm)	6	7	8	7
Spread ratio	6.6	6	4.5	6.8

XIII. CHEMICAL PARAMETERS

13.1 Moisture Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (4.00 %), Fortified *S 2; (4.00 %), Fortified *S 3; (4.00 %) moisture was lower than that of the control sample *C S; (4.50 %), This may be due to the low water absorbing capacity of multi grains (wheat, barley and finger millet), Gernah *e al,.* (2010).
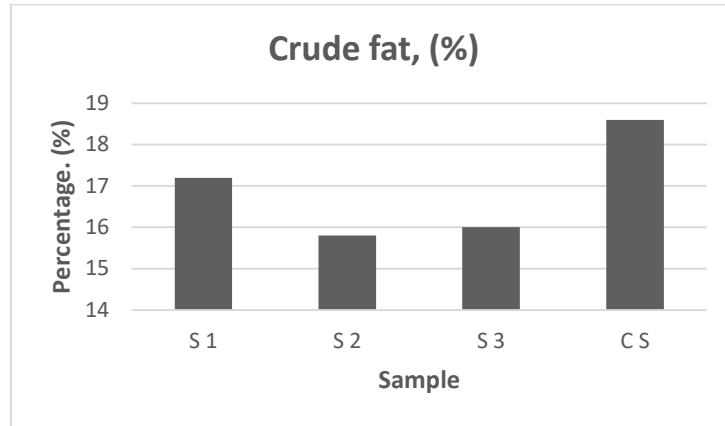

13.2 Ash Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (1.68 %), Fortified *S 2; (1.46), Fortified *S 3; (1.42 %). Ash content was higher than that of the Control sample *C S; (2.5 %) as it consists of high amount of dry matter and mineral composition, Omeire and Ohambele (2010).
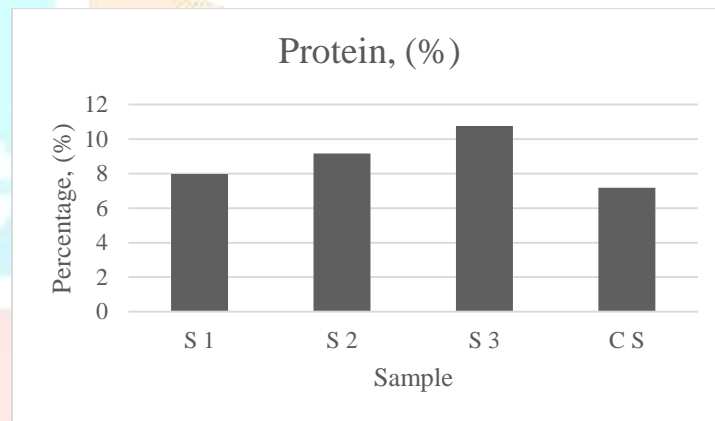
13.3 Crude fat Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (17.20 %), Fortified *S 2; (15.80 %), Fortified *S 3; (16.00 %) crude fat content was lower than that of the Control sample *C S; (18.60 %). As by usage of low fat and the multi grains (wheat, barley and finger millet) having low fat content when compared to the control samples, Ikuomola *et al.,* (2017).
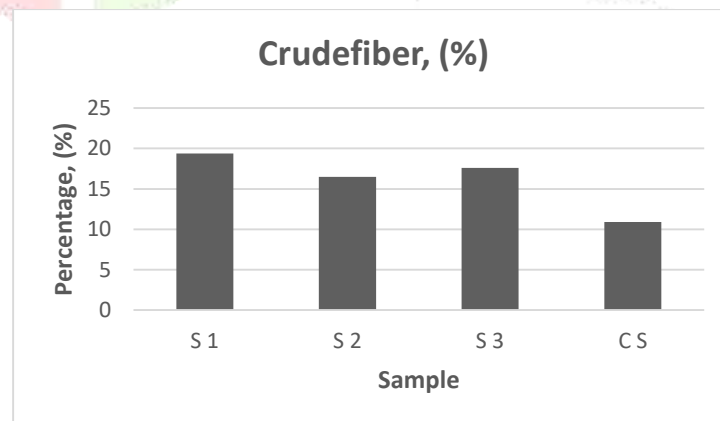

13.4 Protein Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (7.98 %), Fortified *S 2; (9.17%), Fortified *S 3; (10.77 %) Protein content was higher than that of the Control sample *C S; (7.18 %). As the multi grain (wheat, barley and finger Millet) having high protein content mainly barley and are also termed as protein rich foods Satinder, Sativa, & Nagi, (2011).
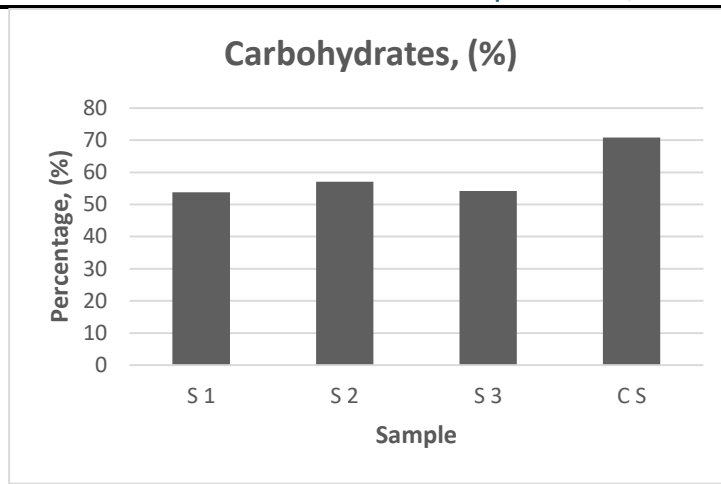

13.5 Crude Fiber Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (19.40%), Fortified *S 2; (16.50%), Fortified *S 3; (17.60 %) crude fiber was higher than that of the Control sample *C S; (10.90 %). This is due to the barley and finger millet has more fiber content than wheat flour and are fiber rich foods as it consisting of more dry matter, Satinder *et al.,* (2011).
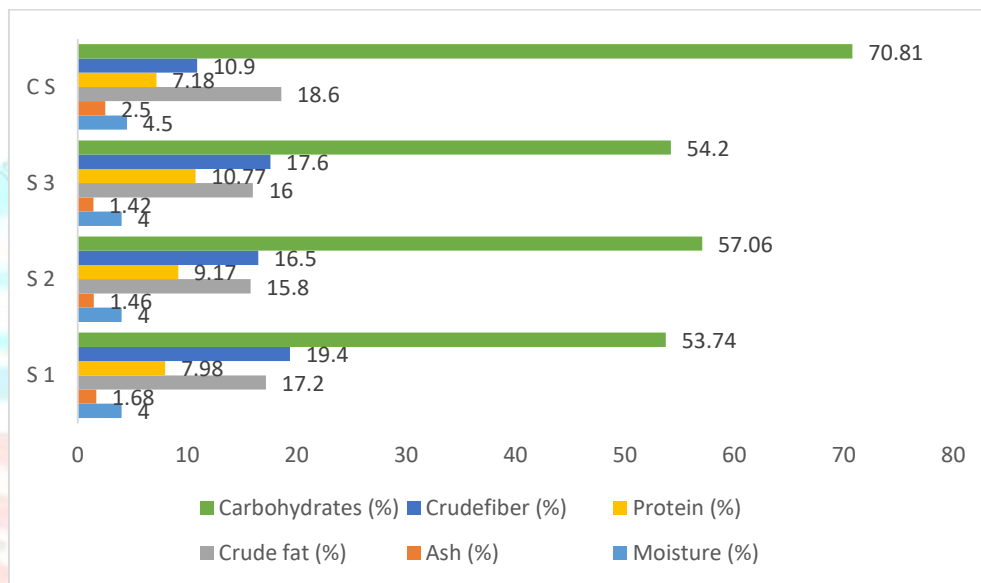

13.6 Carbohydrates Content

In the fiber and protein enriched multi grain cookies Fortified *S 1; (53.74 %), Fortified *S 2; (57.06 %), Fortified *S 3; (54.20 %) Carbohydrate content was lower than that of the Control sample *C S; (70.81 %). The low carbohydrate content and increase in fiber content of the cookies have several health benefits as it improves digestion and reduces constipation, Gernah *et al.* (2010).

Carbohydrates, (%)

XIV.　　COMPARISON CHART

(Fortified *S 1 (80:10:10), Fortified *S 2 (60:10:30), Fortified *S 3 (60:20:20), Control sample *C S)
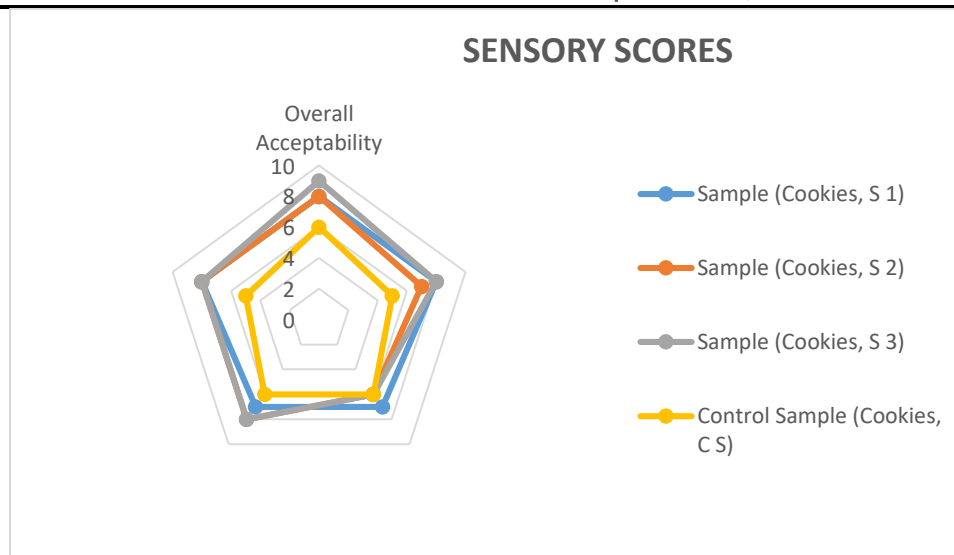

XV.　　NUTRITIONAL COMPOSITION OF FIBER ENRICHED MULTI GRAIN COOKIES

Parameters	Fortified *S 1 (80:10:10)	Fortified *S 2 (60:10:30)	Fortified *S 3 (60:20:20)	Control sample *C S (60:40)
Moisture (%)	4	4	4	4.5
Ash (%)	1.68	1.46	1.42	2.5
Crude fat (%)	17.20	15.80	16.00	18.60
Protein (%)	7.98	9.17	10.77	7.18
Crude fiber (%)	19.40	16.50	17.60	10.90
Carbohydrates	53.74	57.06	54.20	70.81

XVI.　　SENSORY EVALUATION OF FIBER ENRICHED MULTI GRAIN COOKIES

16.1 Sensory (Organoleptic Quality)

Fiber and protein enriched multi grain cookies, where the product is developed and was assessed for sensory evaluation 9-point hedonic scale (**Poonam Dhankhar, 2013**). The results proved with high value of overall acceptability of 3 different proportional samples, Fortified sample *S 1; (8), Fortified sample *S 2; (7), Fortified sample *S 3; (8). The Fortified sample *S 3; (9); (60:20:20) is highly acceptable when compared to Fortified sample *S 1 and Fortified sample *S 2 for its color (8), appearance (9), taste (9), Texture (9), Chewing ability (9). Cookies were attributed with a higher overall acceptability score than that of the Control sample *C S; (6), by the panelists and the good flavor of multi grain cookies was liked when compared to that of the control sample cookies. Ikuomola *et al.,* (2017).

Sensory (Organoleptic quality) of cookies (S 1, S 2, S 3, C S)

XVII. CONCLUSION

Barley and finger millet being the richest of fiber and protein which is available in bio-available form can be consumed by fortifying with staple foods. Barley and finger millets are cost effective when compared with fiber and protein supplements. Products prepared from the barley and finger millet can be consumed to overcome protein and fiber deficiencies. With the available resources, the requirement can be fulfilled.

XVIII. REFERENCES

1. A.O.A.C. (1980) Official methods of analysis 13^hEdn. Association of Official analytical chemists, Washington, D.C.
2. AACC. (2000). *Approved Methods of the American association of central chemists* ($17^{th}ed$). St. Paul, MN: Author
3. Abeshu, Y., & Abrha, E. (2017). Evaluation of proximate and mineral composition profile for different food barley varities Grown in Central High lands of Ethiopia.
4. Alka, V., Pinky, B., & Neelam, K. (2017). Grab a healthy bite: Nutritional evaluation of barley-based cookies.
5. Alobo, A. P. (2001). Effect of. Sesame seed on millet biscuit. *Plant Foods for Human Nutrition,* 56, 195 – 202.
6. AOCS. 1998. Official Methods and Recommended Practices of the American 0:1 chemist's Society ($5^{th}ed$). AOCS press, Champaign, Washington *Asian journal of Dairy & Food Research 36(1)*
7. Ayo, J. A., Ayo, V. A., Nkama, I., & Adeworie, R. (2007). Physicochemical, invitro digestibility and organoleptic evaluation of acha – wheat biscuit supplemented with soy bean flour. *Nigerian Food Journal,* 25, 15 – 17.
8. Barbeau, W.E., & Hilu, K.W. (1993). Protein, Calcium, Iron and amino acid content of selected wild and domesticated cultivators of finger millet. *Cogent Food & Agriculture, 3(1), 1293471*
9. David, O., Arthur, E., Kwadwo, S.O., Bada, E., & Sakyi, P. (2015). Proximate Composition and some functional properties of soft wheat flour. *European Journal of food Science and Technology, 2, 19-28*
10. Dhankhar, P., & Tech, M. (2013). A study on development of coconut-based gluten free cookies. *Dietary fiber in Human Nutrition.* Boca Raton, FL: CRC Press, 183-252
    Enugu: OCJANCO Academic.
11. Gernah, D. I., Senger, I. A., & Audu, J. O. (2010). Physico – chemical and sensory evaluation of cookies produced from wheat and brewers spent grain composite flour. *Nigerian Food Journal, 28, 440 – 447.*
12. Hussain, S., Muhammad, F. A., Butt, M. S., Khan, M., Ali A (2000) Institute of Food Science and Technology, University of Agriculture, Faisalabad – Pakistan.
13. Ikuomola, D. S., Otutu, O.L., & Olunivam, D. D. (2017). Quality assessment of cookies produced from wheat flour and malted barley (Hordeum Vulgare) bran blends. *International Journal of Innovative Research in Science Engineering and Technology, 4(2),* 753-758
14. Joel, N., Fatima, K., & Stephen, F. (2014). Production of quality assessment of enriched cookies from whole wheat and full fat soya. *Journal of food science and technology, 51(10), 2671-2677*
15. NIDDK, (2008) (National institute of diabetes and digestive and kidney diseases) Natinal Digestive Diseases Information Clearing house, national institute of health U.S. Department of health and human services publication number 08-4269.
16. Nur Oktavia Suci lestari, Erni Sofia Murtini. (2017) Formulas in Cookies Sumbar Protein Berbahan Tedung Kacang Tunggak Sebagai Upaya Pemanfaatan Komoditas Lokal *Journal Technologi dan Industri Pangan 2012,* pages 194-200
17. Okaka, J.C., & Ene, G.L. (2005). *Food Microbiology: Method in food safety control* (p. 262).
18. Okpala, L.C., & Okol, E.C. (2014). Development of cookies made wirt cocoyam, fermented Sorghum and germinated pigeon pea flour blends using response surface methodology. *Plant foods for Human Nutrition, 43(2), 97-104*
19. Omeire, G. C., & Ohambele, F. I. (2010), Production and evaluation of biscuits from composite wheat/ defatted cashew nut flours. *Nigerian Food Journal, 28, 401 – 406.*
20. Popil, S. and dhindsa, K. S. (1980). Quality characteristics of improved wheat varieties of Haryana and Punjab. Bull. Grain Technol., 18: 10-16
21. Satinder, K, sativa, S., & Nagi, H. P. S. (2011). Functional properties and anti – nutritional factors in cereal bran. *Asian Journal of Food and Agro – industry, 4, 122 – 131.World Journal of Food Science and Technology, 1(3), 97-100*
22. Yadesa Abesgha, Esayas abrha. Evaluation of Proximate and Mineral Composition Profile for Different Food Barley Varieties Grown in Central Highlands of Ethiopia. *World Journal of food science and Technology.* Vol. 1, No.3, 2017, pp. 9-100