Original Research Article

Evaluation of physical, chemical and sensory properties of multigrain cookies prepared using wheat, oats and sorghum flours

Abstract

Barley, oats and wheat flour was used to formulate composite flour (CF). Composite flour (CF) was made by substituting wheat flour with oats and barley in different proportions of blending, that is 20%, 40%, 60% and 80%. The physical and functional attributes of different blends of composite flour were studied. Different composite flours are used with different ratios to prepare cookies. The qualitative analysis of the prepared multigrain cookies was examined on the basis of physical and proximate analysis. In composite flour, the content of fat, protein and carbohydrate increased as the mixing proportion of the flours increased steadily. The Water absorption capacity (WAC) and swelling capacity (SC) of the composite flours progressively increased as the proportions of the flours blending increased. Furthermore, the diameter of the cookies also decreases with increasing level of blending proportion in wheat flour, and the same effect can increase the hardness nature of the cookies. The cookies prepared from the 80% blend (CF4) achieved the highest overall acceptability score.

Keywords: composite flour, barley, oats, wheat, cookies

1. Introduction

Healthy diet adoption is one of the crucial way to eradicate our self from disease causing agents. The increasing awareness about benefits of intake of healthier diets containing natural nutritionalconstituents has led to the development of a chain of functional food stuffs (Chauhan et al. 2016).Developing the quality functional foods is a challenging task for several food industry due to limited source of plant materials with its nutritive constituents, technology limitation and sensory attributes. Previously most of the bakery and confectionery food items are produce from wheat flour (Diana et al. 2007) could be attributed to its gluten content.

Gluten is a storage protein of cereals crops, as it has vital function in dough and bread manufacturing process (Woodward, 2015) but its presence in wheat flour makes most of the population more sensitive to the several harmful disorders such as wheat allergy, celiac disease, dermatitis herpetiformis, and gluten ataxia.

Thus gluten free diets is a good solution for gluten sensitive populations which has led to develop such a nutritive composite flour from oats and barley. However, novel composite flour enriched with nutritional ingredients like cereals crops, tubers, starches, legumes (Bourre et al. 2019; Noorfarahzilah et al. 2014) and multigrain premixes (Kumar, 2015) in which wheat flour is replaced with other cereal grain flour thereby; reduced the risk of diet-related disease and allergies(Rosell and Matos, 2015). In addition, wheat flours blended with oats and barley cereals used to prepare bread in a bulk scalein order to maintain the proper dough consistency (Badiu et al. 2014).Other than this, other kind of composite flours are also used to manufacture bakery food products such as pasta (Seczyket al. 2016), bread (Ho et al. 2013; Astaet al. 2013) and cookies (Cheng and Bhat, 2016; Zouariet al.2016).Therefore, cereal based flours have been used to produce various kinds of staple food stuffs worldwide for high nutritive and energy values (Tebben et al. 2018; Xu et al. 2019).

Gluten free cookieis a principal bakery food product develop from legume or cereal fortification, act as a sweeteners, shortenings and leavening agents. In addition, other cereal crops such as cassava, corn, rice, chestnut are used to produce flours and with starch premixes develop composite flour for small baked food productssuch ascookies production (Simons and Hall, 2018).

The present study was commenced to investigate the physical and functional properties of composite flour by supplementing wheat flour with oats and barley flour. The composite flour was further employed to make cookies, and assessed the cookies physical and sensory characteristics.

2. Materials and methods

2.1` Raw materials

All the required samples of wheat, oats and barley grains were collected from the Meerut local market, India.

All the collected cereal grains were fined through the dry milling process into flours. Fined flours of wheat, barley and oats were cleaned by passing through the 30 mm mesh sieve filters. Composite flour was prepared by mixing the different combination of barley (BF), oats (OF) and the wheat (WF). Composite flour (CF) of collected cereal grains was used tosubstitute wheat flour with CF at various proportions *i.e.*

10% (TF1), 20% (TF2), 30% (TF3), 40% (TF4). The prepared composite flours was then packed in air tight container and kept for further studies. While sample treated as control sample where no addition of barley and oats flour in wheat flour.

2.2 Proximate analysis of composite flour

Protein, fat, moisture, ash and crude fiber were calibrated according to theAOAC, (2000) standard protocol. The carbohydrate content in the sample was evaluated by using the subtraction method *i.e.*(%) carbohydrate= 100-%(protein+fat+fiber+ash+moisture) as described by James, (1995).The energy content of the samples were determined by Nielsen, (2009).

2.3 Physical properties of composite flour

Bulk density of flour is the density calibrated without the compression of flour. The higher bulk density of flour suggests the higher suitability of flour for use in food stuffs preparation as it contribute greater thickness to the food products on contrary to it low bulk density flour could be used in the formulation of bakery food products preparations (Chandra et al. 2014). The bulk density was calibrated as wt/vol. of the sample.Tap and true density of samples were determined according to the Deshpande and Poshadri (2011) method.

Porosity was calibrated through the pycnometer (Mohsenin, 1986). This porosity determination was accurately measured according to the formula:

$$\phi = 1-(d/d_{max}) \qquad \text{Eq (1)}$$

Where, d= bulk density; and d_{max}= maximum bulk density when all the void space are filled.

2.3 Functional properties of composite flour

Water absorption (WA) and oil absorption capacity (OAC) are calibrated according to the method of Sosulski, (1976). 1g of thecereal flour sample was suspended with 10ml of distilled water or refined soybean oil under ambient temperature for 30min and centrifuged reaction mixture for 10min at 2000Xg. Each obtained value was represented as (%) water and oil bound per gram of undertaken sample.

Swelling power (SP), solubility capacity (SC) and alkaline water retention capacity of prepared flour sample wascalibrated using the AOCC method, (2000).

2.4 Flour energy content calculation

The flour energy content was measured simply by equating and multiplying the number of grams of carbohydrates, protein, and fat by 4 kcal, 4 kcal, and 9 kcal, respectively. Then added each of them to obtain energy content. 100g of flourwas used as sample for calibration purpose.

2.5 Cookies formulation

The cookies were prepared in (%) combination of (80:10:10), (60:20:20), (40:30:30), (20:40:40)and 100:0 (treated as control sample) of WF:CF, respectively. Henceforth, since oats and barley contain lesser amount of gluten content, while sugary syrup containingcookies formulation was electedfor further study. Additional ingredients are also included in the dough preparation like amount of sugar, shortening, salt, water and other ingredients were added to maintain the quality cookies flour production (AOCC, 2000). Cookies were made using the composite flour of cereals, fat, sodium bicarbonate, ammonium salt and water. Proximate analysis of prepared cookies were determined according to AOCC, (2000). Following this methodology, energy and carbohydrate content were also evaluated in the same manner as calibrated for composite flour.

2.6 Physical evaluation of cookies

The calibration of cookies diameter (width), thickness and spread factor was evaluated according to the following AOCC, (2000) method.Spread factor ratio was measured by calibrating the diameter and thickness of cookies using the formula:

$$\text{Spread ratio: } D/T \qquad \text{(EQ. 2)}$$

Where, D is the diameter and T is the thickness of cookies. Breaking strength of cookie was evaluated using the HDP/BS blade.

2.7 Sensory evaluation

Sensory evaluation of cookies was done on the basis of overall acceptability of their color, flavor, smell, elasticity, firmness and texture which can be counted as 9-point hedonic scale.

A nine point hedonic scale with 1 point scale is equivalent to completely product rejection, 5 point scale indicate neither like nor dislike and 9-point hedonic scale display extremely agreed to use (Dutcosky, 2011).The data obtained in this study for calibrating the overall acceptability index can be calculated according to the equation:

$$IA (\%) = A \times 100/B \quad (EQ. 3)$$

Where, A is the average grade acquired by the prepared cookies and B is the maximum grade obtained after the product acceptability (9).

2.8 Statistical analysis

Experimental data was analyzed using one-way and two way analysis of variance (ANOVA) trials in a completely randomized design (CRD) with three replications. Stats data was analyzedby using the software SPSS vers. 18. A significant level of 5% was selected to interpret theobtained results after statistical investigation. Critical difference (CD) was calibrated to determinethe significance difference between the samples for each parameter.

Table 1 Cereal grains combination for multigrain cookies production

Combinations	Wheat flour	Oat flour	Barley flour
Control	100%	-	-
CF1	80%	10%	10%
CF2	60%	20%	20%
CF3	40%	30%	30%
CF4	20%	40%	40%

Wheat flour=WF; Oats flour= OF; Barley flour= BF and composite flour= CF

3. Results and Discussion

3.1 Proximate analysis of wheat and composite flour

Oats and barley flours and wheat flour were comparatively distinguished on the basis of proximate composition at significant p<0.05 level. Wheat flour from wheat grains have more than (14%) moisture content thereby; WF is more prone to contaminated with microbial growth and insects.The moisture content was found in different composition of flours blends has no statistically differenceas mentioned in table 2. Similar results were obtained by Iwe et al. (2016) for proximate analysis for rice, brown cowpea seed composite flour. Moisture content is also affected by type of milling technology used and percent moisture content present in composite and wheat flour.

Table 2. Proximate composition of different composite flour blends

Parameters	WF	CF1	CF2	CF3	CF4	CD P<0.05 (level)
Moisture (%)	13.08±0.21	12.54±0.12	12.23±0.92	12.14±1.2	12.02±0.22	N/A
Protein (%)	13.20±0.075	13.56±0.125	13.65±0.015	14.05±0.26	14.65±0.325	0.218
Fat (%)	1.80±0.063	2.2±0.07	2.56±0.072	2.69±1.22	2.84±1.06	0.234
Carbohydrate (%)	69.90	69.71	70.54	70.66	71.67	-
Ash (%)	0.75±0.025	0.67±0.015	0.90±0.012	1.04±0.122	1.09±0.047	1.09
Crude fiber (%)	0.62±0.005	1.01±0.012	1.74±0.225	2.07±0.029	2.49±0.25	0.186
Energy value (KJ)	292.8	314.12	329.44	342.167	355.14	-

CD= Critical differences; WF= Wheat flour; CF1=(composite flour 10% oats + 10% barley mixing); CF2= (composite flour 20% oats + 20% barley mixing); CF3=(composite flour 30% oats + 30% barley mixing); CF4= (composite flour 40% oats + 40% barley mixing)

The oats and barley composite flour have greater protein content than wheat flour as presented in table 2. It was varied from 13.56% to 14.65% and relatively higher as compared to wheat flour (13.2%). High percentage of total protein content in CF4 composite flour has been increased than control (WF) sample as shown in table 2. As per statistical analysis the percentage of protein content of composite flours were differed significantly than the wheat flour (WF) sample.

Fat content of composite flours was significantly increased over wheat flour (WF), whichconsidered as control sample.Although, fat content of blended flour varied from 2.2% to 2.84%, its increased contentis reflected at all the level of blending percentage as it was statistically differed due to CD values differences at $p<0.05$ level.

The (%) carbohydrate content in composite flours was differed than the control. Its content varied gradually from 69.71 to 71.67 due to increased percentage of blending of oats and barley flours than wheat flours as displayed in table 2. With the increment in blending proportion of composite flours

(20:40:40), the ash content of the flour was elevated as compared to wheat flour. The composite flour ash content was significantlydiffered from 0.67-1.09% as it was concluded from these results that CF4 composite flour has greater purity index over (WF) control sample.

In addition, the fiber content of blended flours assessed and its content varied from 1.01 to 2.49%indicating that fiber content was increased with increment in CF4 blending proportion over control sample. High fiber content containing composite flour (CF4) intake eradicate the problem of bowel syndrome and colon cancer. Same high fiber content consumption also reduced the risk of Type-2 diabetic disorder.

As per obtained results shown in table 2 shows that energy value (KJ) increased with the increment in percentage of composite flour than wheat flour content. The basic reason behind of energy value increment was due to increment in protein and fat amount as blending proportion of composite flour is increased.

3.2 Physical characteristics of composite flours

As more and more composite flour was added into the wheat flour, the bulk density of developed flours was decreased. The bulk density varied from 0.41gm/l (CF4) to 0.49gm/l (CF1) as compared to wheat sample as mentioned in table 3. Gradual decrement in bulk density was observed as the reduction in the size of particles and density of the flour. Bulk density is an important factor in determining the packaging requirement, material handling and application in wet processing in the food industry. Same decrement pattern of composite flours noted in case of tap density (gm/l) as the amount of other cereals crops in wheat flour is increased. It define the fitness of the composite flour.

Table 3. Physical properties of composite flours blends

Parameters	WF	CF1	CF2	CF3	CF4	CD (p<0.05 level)
Bulk density (gm/l)	0.52±0.11	0.49±0.02	0.48±0.05	0.45±0.17	0.41±0.26	N/A
Tap density (gm/l)	0.74±0.26	0.71±0.11	0.70±0.07	0.69±0.31	0.67±0.08	N/A
True density (gm/l)	0.75±0.16	0.73±0.18	0.69±0.24	0.68±0.30	0.65±0.42	N/A
Porosity (%)	30.95±0.12	33.28±1.02	30.5±0.27	32.85±1.45	33.95±1.51	1.93

CD= Critical differences; WF= Wheat flour; CF1= (composite flour 10% oats + 10% barley mixing); CF2= (composite flour 20% oats + 20% barley mixing); CF3=(composite flour 30% oats + 30% barley mixing); CF4= (composite flour 40% oats + 40% barley mixing)

Calibrated true density of wheat flour has maximum value of (0.75gm/l) as compared to other composite flours. It was observed in (table 3) that there is a gradual decrement in the true density of composite flours (CF) and this least decrement (0.65gm/l) was noted in (CF4) flour. This gradual decrement in true density reading of composite flour was found highest in CF4 blend because of higher percentage of addition of oats and barley flours in wheat flour.

Lastly porosity values in composite flour varied from 33.28±1.02 to 33.95±1.51, where CF4 combination has found higher porosity value than wheat flour sample. As per the statistically analyzed data of table 3, which determined that there was significant difference between the formulated blends and wheat flour at ($p<0.05$ level).

3.3 Functional properties of composite flours

Functional properties of different blends of flours were studied and each important properties were displayed in table 4. For the table 4, it was concluded that the water absorption ability of flours increased as the blending proportion was increased. At 20% blend WAC was 0.66 (ml/gm) which raised up to 0.97ml/gm at 80% blending in wheat flour. These obtained values of WAC were somewhat greater than the values of 2.20g/g and 4.81g/g as reported by Tenagashaw, (2015) of food stuffs developed by the combination of teff fortified with soyabean and orange flesh sweat potato. Increment of water absorption characteristics in 80% blended composite flour is due to the disruption and dilution of gluten matrix by incorporation of fibers in flours whichincreased dough water absorption capacity. Fiber inclusion in composite flour facilitates the hydrogen bond formation and interchange of disulphide bonding between the non-gluten proteinswhich ultimately breaks the starch-protein complex and promotes the swelling behavior of blended flours as explained by Blessing et al. (2014).

Table 4. Functional properties of composite flours blends

Parameters	WF	CF1	CF2	CF3	CF4	CD (P<0.05 level)
WAC(ml/gm)	0.66±0.12	0.7±0.06	0.77±0.04	0.90±0.12	0.97±0.07	N/A
OAC(ml/gm)	1.10±0.14	0.92±0.17	0.98±0.14	1.09±0.56	1.08±0.55	N/A
SP (%)	6.25±1.2	8.41±0.08	9.06±0.17	9.41±0.09	9.47±1.06	1.418
SC (%)	15.45±1.54	6.94±1.06	9.67±0.08	10.56±0.13	10.96±1.22	3.67
AWRC (%)	56.66±0.33	57.63±1.71	57.87±1.29	58.33±1.53	58.67±1.66	0.534

WAC= Water Absorption Capacity, OAC= Oil Absorption Capacity, SP= Swelling Power, SC= solubility capacity, AWRC= alkaline water retention capacity

From table 4 and fig 1 presents the oil absorption capacity (OAC) of blended flours that was lesser than the wheat flour.

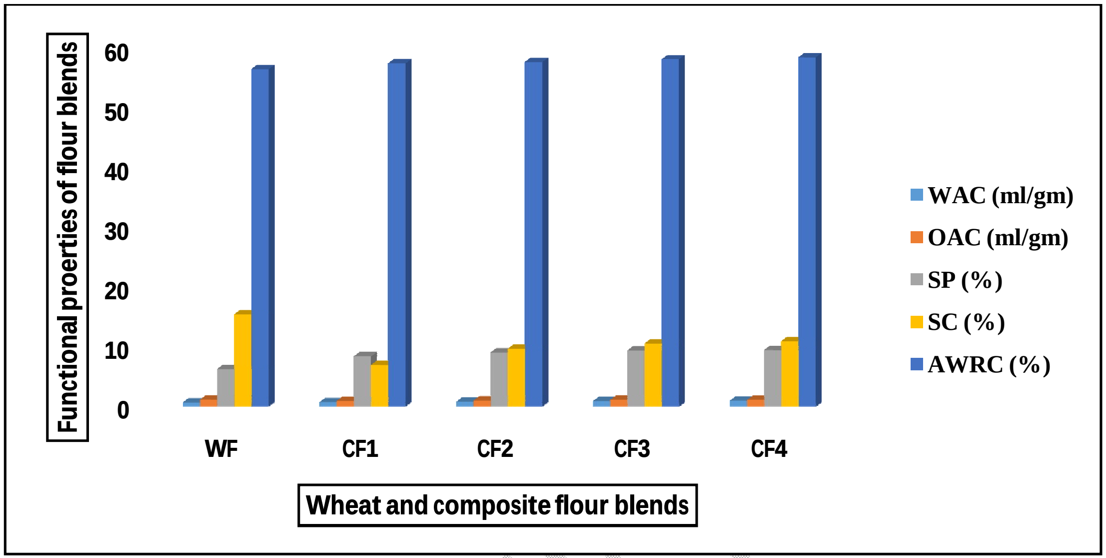

Figure 1. Functional properties of composite flours blends

OAC value varied from 0.92 (ml/gm) to 1.15 (ml/gm) as the blending proportion of oats and barley flours in wheat flour is increased. Chandra et al. (2013) reported that gluten protein presence in flour raised the ability of protein to bind with oil, thereby; OAC was found higher in wheat flour as compared to other blended flours. Another functional parameter of blended composite flour is swelling power (%) which gradually show increment in swelling behavior in composite flour as compared to wheat flour. Its values consistently showed increment from 8.41(%) to 9.47(%) upon increment in blending proportion of flours in wheat flour.

However, solubility capacity parameter reflect the soluble starch content in flour and it was observed in this study that the solubility capacity index gradually increased with the increment in the blending ratio of oats and barley in wheat flour as water interacted with the flour. Similar kind of observations was reported by Iwe et al. (2016). In addition, higher (AWRC) index value reflect the greater cookies diameter.

All the formulated flours significantly showed higher AWRC 58.67% (CF4 at 80% increment in blending proportion) than the wheat flour as already discussed previously by Ajatta et al. 2016 for composite flours development from wheat.

3.4 Preparation of multigrain containing cookies

The prepared cookies from different blends of flours other than wheat flour has lower moisture content, which reflects the lesser chance of contamination with microbial gents and it has better storage stability as well. As per presented data in table 6, which showed the increment in the blending proportion of different flours for cookies preparation, reflected the alteration in the moisture content from average value 2.41% of the CF1to 2.23% of the CF4flour cookie. This increment in the moisture content could be augment the water binding capability of composite flour.Thus the water binding capacity of all composite flour was found to be higherover wheat flour.

The blend proportion and its interaction with water were observed to have a significant effect on the protein content. It was observed the protein content of the composite-wheat blend for cookies preparation was lied in the ranged from 6.49 to 6.98%. The studied results were found in close agreement to the Ojinnaka*et al*., (2009) who reported the cookies made from taro-wheat blend has more nutritious values as compared to wheat flour made cookies.

The fat content of the cookies was found to be significantly affected (at $p<0.05$) with blend proportion and their interaction.Increment in the amount of fat in the cookies confirmed with the blending proportion increment of composite flours in wheat flour. This is may be due to the presence of higher fat content in the oat and barley flour than wheat flour.

Along with this, substitution of wheat flour with composite flour, could raise the ash content in cookies. The ash content increment may be due to presence of high mineral content in the composite flour than wheat flour and selected composite flour can used to make cookies.

Since composite flour having barley and oats flour was observed to have significant amount of ash content over wheat flour, this could be responsible for the higher ash contents of cookies with higher proportion of composite flour.In composite flour blend cookies, the fiber content varied from 0.86 to

1.70%. The average values of crude fiber content of the cookies showed significant increment with an increase in blending proportion of composite flour.

The studied results were found consistent with the reported by Ikumola*et al*. (2017) who showed that the blending of citrus by-products flour with wheat flour could raise crude fiber content. Bolarinwa, et al. (2019) also reported that the increment of crude fiber content (from 0.46% to 1.09%) in the sesame fortified cookies. In addition, all the formulated blend flours showed higher carbohydrate contents, which gave cookies more chances to acceptability. This exceptional level of carbohydrate content is due to the presence of ingredients such as wheat, oat and barley flour with high content of carbohydrates. The obtained result was found to consistent with the Ojinnakaet al.(2009) study.

The energy values varied from 928 to 1043 KJ/100gof the composite-wheat flour cookies. Thisenergy values increment is may be due to increment in the proportion of composite flour as compared to wheat flour. The possible reason behind this increment may be due to the fact that with an increase in the composite flour proportion, the fat and protein content would also increase but it show slight decrement in carbohydrate content as shown in table 5.

Table 5. Proximate evaluation of composite flours blends made cookies

Parameters	**WF cookies**	**Composite formulation of flours for cookies**				**CD (P<0.05)**
		CF1	**CF2**	**CF3**	**CF4**	
Moisture (%)	2.39±0.09	2.41±0.22	2.23±0.15	2.98±0.12	2.23±0.12	0.201
Protein (%)	6.36±0.021	6.49±0.25	6.20±0.21	6.08±0.18	6.98±0.31	0.458
Fat (%)	20.75±0.30	20.89±0.19	21.70±0.37	23.67±0.27	23.97±0.53	0.701
Ash (%)	0.91±0.14	0.91±0.40	0.95±0.05	1.05±0.04	1.09±0.13	N/A
Crude fiber (%)	0.66±0.06	0.86±0.49	0.96±0.10	1.55±0.15	1.70±0.20	0.333
Carbohydrate (%)	69.11	68.64	68.11	64.39	63.51	N/A
Energy value (KJ/100g)	925.553	928.738	936.798	1022.7832	1043.056	N/A

CD= Critical differences; WF= Wheat flour; CF1=(composite flour 10% oats + 10% barley mixing); CF2= (composite flour 20% oats + 20% barley mixing); CF3=(composite flour 30% oats + 30% barley mixing); CF4= (composite flour 40% oats + 40% barley mixing)

3.5 Physical evaluation of developed cookies

Physical evaluation of the multigrain cookies and wheat cookies were shown in table 6. Comparative analysis of multigrain flours with wheat flour was done on the basis of physical parameters and decide the quality of developed cookies.

Table 6. Physical evaluation of composite flours blends

Parameters	WF cookies	Composite formulation of flours for cookies				CD (P<0.05 level)
		CF1	CF2	CF3	CF4	
Diameter (cm)	3.9±0.20	3.86±0.17	3.80±0.24	3.72±0.12	3.26±0.06	N/A
Thickness (cm)	1.14±0.18	1.33±0.12	1.27±0.14	1.18±0.19	1.15±0.14	N/A
Spread factor	3.55±0.29	2.9±0.22	2.95±0.18	3.15±0.22	3.17±0.18	N/A
Spread ratio	35.5±0.48	29.05±0.34	29.92±0.26	31.5±0.21	31.65±0.34	0.588
Hardness (N)	31.66±1.29	33.66±0.91	32.94±1.77	46.80±1.23	47.66±1.61	2.356

CD= Critical differences; WF= Wheat flour; CF1=(composite flour 10% oats + 10% barley mixing); CF2= (composite flour 20% oats + 20% barley mixing); CF3=(composite flour 30% oats + 30% barley mixing); CF4= (composite flour 40% oats + 40% barley mixing)

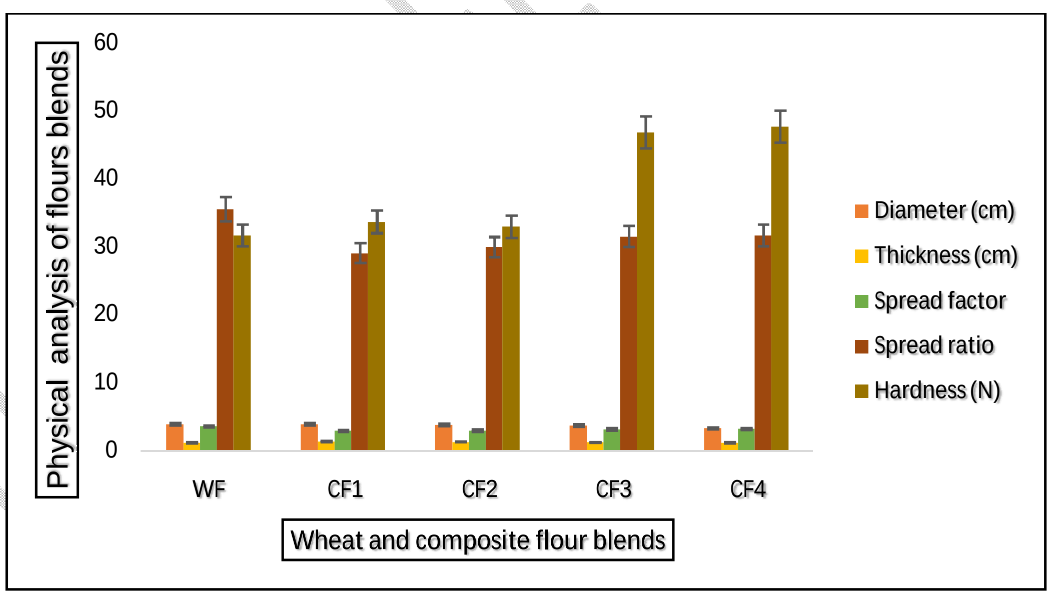

Figure 2. Physical analysis of developed composite flours and wheat flour

Above table 6 and fig 2 showed the diameter of the prepared cookies developed from flours decreased with increasing degree of flour blending proportion. The obtained results were found in the same lines as reported by (Oluwatoyin, 2016).As per obtained statistical data, it was observed that there was no significant difference was found among the diameter of developed cookies preparedby mixing flours in a different ratio in wheat flour. The degree of thickness is also decreased significantly by increasing the levels of supplementation as mentioned in table 6. Additionally, as the increment of blending flour ratio in wheat flour is increased gradually, the spread ratio is also raised consistently. This gradual increment in spread ratio is straight forwardly concern with the spread factor, that was increased as the level of supplementation is elevated.The studied results were found in full consistent with those of Francine et al. (2011) study.

The study results (table.6) showed that hardness of the developed cookies is increased with increment in the level of supplementation.Control cookies show hardness value (31.66N), whereas its value show gradual increment from 33.66N to 47.66 N when the degree of flour blending is increased from 20% to 80% in wheat flour. The obtained results were found similar to earlier reported results concerning with cookies prepared from wheat-cowpea (McWatters*et al*., 2003) and wheat–soybean (Shrestha and Noomhorm, 2002) flour blends. Along with this few earlier studies pointed out views and justified the mechanisms related to the cookies diameter compression (i.e. spread) is significantly decreased as the wheat flour is added with other cereal flours. However, it has been suggested that spread ratio is also affected by the interaction of ingredients such as protein and starch for the available water during dough preparation (Nirmala et al. 2011).

In terms of sensory evaluation of developed cookies all the respective flour formulations were acceptable by consumers and judges and C4 (80% blend) was preferred sample over other samples because it impart the desired sensory characteristics to the cookies.

Table 7. Sensory evaluation of cookies developed from CF4 blended flour

Sensory Parameters of cookies (CF4)	Results
Elasticity (%)	56.78 ± 0.12
Firmness (g)	718.06 ± 44.34
Flavor	8.17 ± 0.71
Texture	7.92 ± 0.79
Color	8.17 ± 0.81
Smell	8.00 ± 0.81
Acceptability (%)	89.65 ± 5.76
Cookies buy intention	3.90 ± 0.59

CF4= (composite flour 40% oats + 40% barley mixing)

Table 7 presents the results of the sensory evaluation performed on the basis of appearance, aroma, texture, color and flavor as well as customers purchase satisfaction of the developed cookies produced from different blends of composite flours of oats and barley. Additionally other sensory attributes such as elasticity and firmness of the product predict the texture of the product (Kasunmala et al. 2020).

However, sensory evaluation of CF4 flour blend source from oats and barley was found acceptable and registered overall acceptability index of the cookies was 89.65%, which indicates a possibility of developing cookies with oats and barley flours; moreover, the value of purchase intention was assessed as 3.9, which is closest to a score of 4.0 that shows would buy frequently; this confirms the probability of using oats and barley flour in the development of gluten-free cookies.

4. Conclusion

The protein content of all the developed composite flour from oats and barleywas found significantly higher than wheat flour. The same composite flour had more fat, carbohydrate and ash content over wheat flour and their increment with the increment in flour blending proportion. The increment in energy content (KJ/100g) is also registered with increase in percentage of composite flour in wheat flour.

In physical properties, it was observed that wheat flour had true density (TD) of 0.75±0.16 g/ml whereas the true density of composite flour is consistently declining from 0.73±0.18 to 0.65±0.42 g/ml. The possible reason of declining in true density is due to the increment of blending ratio in wheat flour. Other than this, it was noted that oil absorption capacity of blended flour was lesser than the control sample.

With the gradual addition of blending percentage of composite flour in wheat flour, the swelling power of composite flour has been increased in a steady manner.

AWRC increment was found maximal in 80% blend compared to 20% blend, thereby;its value varied from 56.66±0.33 to 58.66±1.66%. The lightness of flour diminished with cumulative percentage increment of composite flour from oats and barley.

Multigrain cookies thickness is affected by increasing the blending flours in wheat flour. Conversely, hardness of theprepared cookies increased with addition of blend flours, but it reduced the brightness of cookies. (80%) blend (CF4) is a preferred choice of the judges for cookies preparation as it contributed desirable appearance, color, texture, smell and flavor which makes them distinguished it from otherflour samples, despite of this, all other samples were also acceptable. Thereby; 80% blended flour sample is suitable choice and it acquired the maximum score for overall acceptability for cookies production. Thus the replacement of wheat flour with composite flours will be profitable business in this sense, as it results into low cost cookies generation**.**

5. References

Chauhan, A., Saxena, D. C., & Singh, S.. Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. CogentFood and Agriculture, (2016) 2(1), 1125773.

Diana, N. R., Mirela, V. G., &Jianu, I.. Studies regarding the chemical composition of several wheat species, flour types and pastes assortments. Bulletin (2007) USAMV-CN 64/2007.

Woodward J.. Coeliac disease. Medicine. 2015. 43:234-238.

Bourre, L., Frohlich, P., Young, G., Borsuk, Y., Sopiwnyk, E., Sarkar, A., Nickerson, M. T., Ai Y., Dyck A. &Malcolmson, L.. Influence of particle size on flour and baking properties of yellow pea, navy bean and red lentil flours. Cereal Chemistry. (2019) 96(4), 655–667. https://doi.org/10.1002/cche.10161.

Kumar, K. A., Sharma, G. K., Khan, M. A., Govindaraj, T., &Semwal, A. D.. Development of multigrain premixes, its effect on rheological,textural and micro-structural characteristics of dough and quality of biscuits. Journal of Food Science and Technology, (2015) 52(12), 7759–7770.

Rosell CM, Matos ME.. Market and nutrition issues of gluten-free foodstuff. Spain: Institute of Agrochemistryand Food Technology (IATA-CSIC); 2015 p. 675–713.

Badiu E, Aprodu I, Banu I.. Trends in the development of gluten-free bakery products. Fascicle VI – Food Technol. (2014) 38:21–36.

Seczyk, L., Swieka, M. and Gawlik-Dziki, U.. Effect of carob (*Ceratoniasiliqua*L.) flour on the antioxidant potential, nutritional quality and sensory characteristics of fortified durum wheat pasta. Food Chemistry 2016 194: 637-642.

Ho, L., Aziz, N.A.A. and Azahari, B.. Physico-chemical characteristics and sensory evaluation of wheat bread partially substituted with banana (*Musa acuminata*X*balbisiana*cv. Awak) peudo stem flour. Food Chemistry 2013 139: 532-539.

Asta, C.D., Cirlini, M., Morini, E., Rinaldi, M., Ganino, T. and Chiavaro, E.. Effect of chestnut flour supplementation on physic0-chemical properties and volatiles in bread making. LWT- Food Science and Technology 2013 53: 233-239.

Cheng, Y.F. and Bhat, R.. Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (*Pithecellobiumjiringa*Jack.) legume flour. Food Bioscience 2016; 14: 54-61.

Zouari, R., Besbes, S., Ellouze-Chaabouni, S. and Ghribi- Aydi, D.. Cookies from composite wheat-sesame peels flours: Dough quality and effect of Bacillus subtilis SPB1 biosurfactant addition. Food Chemistry 2016; 194: 758-769.

Tebben, L., Shen, Y., & Li, Y.. Improvers and functional ingredients in whole wheat bread: A review of their effects on dough properties and bread quality. Trends in Food Science and Technology, (2018); 81, 10-24.

Wu, T., Yan, L., Li, Y., Qian. H., Liu, L., Tong, L., Zhou, X., Wang, L., & Zhou, S.. Effect of milling methods on the properties of rice flour and gluten free rice bread. LWT. Food Science and Technology, (2018); 108, 137-144.

Simons, C. W., & Hall, C.. Consumer acceptability of gluten-free cookies containing raw cooked and germinated pinto bean flours. Food Science & Nutrition, (2018); 6(1), 77-84.

AOAC. (2000). Association of Official Analytical Chemists. Official methods of analysis. 15thed. Arlington: Association of Official Analytical Chemists.

James, S. C.. Experimental Methods. In: Analytical Chemistry of Foods, Champman& Hall, New York, (1995); 28. http://dx.doi.org/10.1007/978-1-4615-2165-5.

Nielsen, S. S. Food analysis, 4th edition. Perdue University West Lafayette, IN (2009); 47907, USA (pp 151-168).

Chandra, S., Samsher, S. and Kumari, D.. Evaluation of the functional properties of composite flours & sensorial attributes of composite flour biscuits. Journal of Food Sci and Technology, (2014); 52 (6): 3681-3688.

Mohsenin, N.N.. Physical properties of plant and animal materials, (1986); p. 20-89. New York: Gordon and Breach Science Publishers.

Sosulski, F. W., Garatt MO, and Slinkard, A. E.. Functional properties of ten legume flours. (1976); Int. J. Food Sci. Technol. 9: 66-69.

Dutcosky, S.D.. Sensory analysis of food. Champagnat University, Curitiba (2011).

Iwe M. O., U. Onyeukwu, and A. N. Agiriga. Proximate, functional & pasting properties of FARO 44 rice, African yam bean & brown cowpea seeds composite flour. (2016); Cogent Food & Agriculture 2: 1142409.

Tenagashaw, M.W.; Kenji, G. M.1; Melaku, E. T. 3; Huyskens-Keil, S.; Kinyuru, JN.. Proximate composition & selected functional properties of complementary foods from teff fortified with soybean and orange-fleshed sweet potato. (2015); RUFORUM Working Document Series 14 (1): 953-965.

Blessing, I.O.. Chemical, functional & pasting properties of wheat (triticum spp.) -walnut (juglansregia) flour. (2014); Food and nutrition sciences, 5, 1591-1604.

Chandra, S. and Samsher S.. Assessment of functional properties of different flours. (2013); African J of agric, 8 (38), 4849-4852.

Oluwatoyin, O., Toyin, A., Temiloluwa, A., Olajumoke, O., Joshua, A., Olubunmi, I., Folashade, O., Samuel, O. and Sulaiman, K.. Some of the functional properties of flours from the commonly consumed selected Nigerian Food Crops. (2016); International Research Journal of Agricultural and Food Sciences, 1(5): (92-98).

Francine Z, Yulia B, Susan D, Arntfield. Physical and nutritionalevaluation of wheat cookies supplemented with pulse flours of different particle sizes. (2011); LWT Food SciTechnol 44:2070–2076.

McWatters, K. H., Ouedraogo, J. B., Resurrection, A. V. A., Hung, Y. C. and Philips, R. D.. Physical and sensory characteristics of sugar cookies containing mixtures of wheat, fonio*(Digitariaexilis)* and cowpea *(Vignaunguiculata)* flours. 2003; International Journal of Food Science and Technology 38: 403–410.

Shrestha, A. K. and Noomhorm, A.. Comparison of physicochemical properties of biscuits supplemented with soy and kinema flours. 2002; International Journal of Food Science and Technology 37: 361–368.

Nirmala M, Jyotsna R, Jeyarani T, Venkateshwara RG. Influence of debittered, defatted fenugreek seed powder and flax seed powder on the rheological characteristics of dough and quality of cookies. (2011); Int J. Food SciNutr 62:336–344.

Ojinnaka, M.C., Akobundu, E.N.T. and Iwe, M.O.. Cocoyam starch modification effects on functional, sensory and cookies qualities. (2009); Pakistan Journal of Nutrition 8(5): 558-567.

Ikumola, D. S., Otutu, O. L., &Oluniran, D. D.. Quality assessment of cookies produced from wheat flour and malted barley (Hordeumvulgare) bran blends. (2017); Cogent Food and Agriculture, 3(1): 1–12.

Bolarinwa, I.F., Lim, P. T., & Muhammad, K.. Quality of gluten-free cookies from germinated brown rice flour. (2018); Food Research, 3(3): 199-207.

Kasunmala, I.G.G., et al.,. Effect of process modifications and binding materials on textural properties of rice noodles. (2020); International Journal of gastronomy and Food Science 21, e100217.