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Usage of Cassava Tubers in Bread Production Technology

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ABSTRACT

Egypt is the largest wheat importer globally, the government is aiming to find alternatives to reduce wheat imports and to cultivate reclaimed lands. Comparative studies were conducted to investigate the effect of substituting portions of wheat flour with cassava flour at levels starting from 20% to75%, on chemical, rheological and sensory characteristics of the Egyptian balady bread that is currently produced from wheat only and to enhance its nutritional and baking quality. Substituting wheat with 30% *cassava* gave the highest carbohydrate content, didn't change any of the rheological properties and no significant difference was noticed between wheat flour and 30% cassava in all sensory tests. Substituting wheat with 40% cassava resulted in elevating protein, fat and fiber percentages than that of other samples. 75%cassava is acceptable and appropriate in terms of their flavor. Wherefore, we recommend expanding cassava cultivation in Egypt due to its acceptability, suitability to the Egyptian environment, health benefits and more importantly its high carbohydrate and fiber contents.

***Keywords*:** Cassava tubers, alternatives, bread, technology

Introduction

Bread is one of the most important staple foods consumed all over the world, Bread wheat is an Egyptian product that represents the main source of carbohydrate and the main diet component for rich and poor Egyptian consumers (El-Soukkary, 2001). Litwinek *et al*. (2013) stated that the total production of wheat grains covers only about 50% of the total Egyptian needs; therefore, the total yield does not satisfy the requirements of the country. For centuries, wheat has been the central component of the typical diet of the country's inhabitants, so per capita consumption of this cereal is amongst the highest in the world as stated by FAO, (2015) Egypt is not only the largest importer of wheat but also the largest wheat consumer and bread eater per capita in the world because the heavy dependency on wheat, according to a report issued by the CAPMAS (2015), for consumption in 2015, the average consumption per capita of wheat reached 141.1 kg in 2015 versus 133.6 kg in 2014.Therefore, searching for other cereal sources, which could be integrated in making wheat flour bread is needed to overcome the wheat gap and satisfy consumers' needs (Litwinek *et al.,*2013). In addition, this would reduce the dependency on wheat imports and increase livelihoods of local farmers who produce crops that may be applied in flour composites (Mitchell, 2008)

Cassava (*Manihot esculenta* Crantz) is a perennial, subtropical, woody shrub, grown as annual and is valued for its underground starchy tubers (roots) (Grace, 1977; Purseglove, 1988; Islam *et al*., 2008). Cassava is the important source of energy as staple food for more than 500 million people in Africa,Latin America and Asia (Hillocks,2002). Tuber of cassava is also used as raw materials in the garment, bakery, food and Pharmaceutical industries (Bokanga *et al*., 1994; IITA, 2011; Fakir *et al*., 2012).

Cassava tuber contains about 70% moisture, 20-30% carbohydrate, 1.0-1.8% crude protein, 1.5-3.5% crude fiber, 0.35-0.45% fat and 8-28 mg HCN/kg of dry mass (Purseglove, 1988; Charles *et al.*, 2005).(Cassava plant parts are rich source of vitamins and minerals. Though tuber is the main product of cassava plant, its young branch and leaf is also edible both for human and animal (Fakir *et al*., 2010). Tuber is the main source of starch and minerals; leaf is the rich source of protein, vitamins and minerals. Cassava flour (10-30%) in combination with wheat flour is used in bread industry to reduce pressure on wheat (Grace, 1977).

Nutritionally, cassava contains potassium, iron, calcium, vitamin A, folic acid, sodium, vitamin C, vitamin B-6, and protein (Montagnac *et al*., 2009). Cassava (*Manihot esculenta* Crantz, Euphorbiaceae) is a staple food consumed worldwide with an estimated 800 million consumers (FAO,

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2000). It is cultivated mainly for its roots and leaves (Ngome *et al*., 2013; Temegne *et al*., 2016) and have acceptable production yield in poor soils with low nutrient availability (Temegne *et al*., 2016).

Cassava is considered as a new non-traditional vegetable crop in Egypt. Introduction and cultivation of cassava in newly reclaimed lands showed great success. In addition, Shams, (2011) stated that cultivation of cassava in traditional agriculture is carried out with no applied fertilizers mainly in North Sinai and North West Coast. On the other hand, guar cluster bean, *Cyamopsis tetragonoloba* (L.) is one of the hardiest legume vegetables.

The main objective of this study is to estimate the nutritional value of cassava tuber flour and use cassava tubers flour to make bread by adding different parentage of cassava tubers flour to replace wheat flour.

Materials and Methods

- Cassava tubers type of Monihotaipi obtained from Ain Shams**:** were grown on the Research Farm of the Environmental Studies and Research Institute, University of Sadat City, Minofiya Governorate.
- Egyptian wheat flour (Gemmayze type 11 and 82% extraction) was purchased from the local market available in the Arab Republic of Egypt.
- Other ingredients include: Sugar or sucrose, water, salt, and instant dry yeast were purchased from the local market available in the Arab Republic of Egypt.

1. Preparation of cassava flour

Fresh tubers were washed, peeled and grated. Grated tubers were dried in hot air oven at 55oC for 24 hrs. The chips were then milled into flour by using an attrition milling machine, then sieved through a 200-microsieve. Finally, the flour is packaged in plastic bags.

2. Chemical analyses of raw materials

Wheat flour and cassava flours were subjected to chemical analysis to determine their chemical composition (moisture, ash, crude protein, crude fat, and crude fiber as described in the (AOAC, 2005).

3. Determination of total carbohydrates

Total carbohydrates were calculated by difference according to the following equation

$$\text{Carbohydrates} = 100 - (\%\ \text{protein} + \%\ \text{fat} + \%\ \text{ash} + \%\ \text{fiber}).$$

4. Functional properties

4.1. Bulk Density

Bulk density was determined by adding (5 g) of flour into (10 ml) graduated measuring cylinder. The cylinder was gently tapped on the bench top 10 times from a height of about 5 cm. the volume and weight were recorded. Per unit and weight were recorded. Bulk density was reported as weight per unit volume (g/ml) (Siddiq *et al*., 2010**).**

5. Preparation of fortified Wheat flour with Cassava flour

Roots of cassava were treated - as previously mentioned, milled and incorporated at various levels to wheat flour (82%extraction) to determine the most suitable substitution levels depending on the chemical and rheological analysis. Eight percentages were tested, i.e. 20, 40, 60.75 and 100%. The final composed two mixtures were blended each individually to ensure the homogeneity of the mixture and kept individually in polyethylene bags at 4 °C for further usage. Percentages were 20, 40 and 50% the best. The best percentages were identified according to the chemical and sensory tests.

6. Dough rheological evaluation of Wheat flour and cassava flour

The rheological characteristics of wheat flour doughs fortified with in different proportions from cassava flour were investigated by examining the effect of farinograph and extensograph characteristics of wheat flour doughs. Rheological tests were done at Food Technology Department, National Research Centre in Dokki, Cairo, Egypt**.**

6.1. Farinograph test

The farinograph test was determined by farinograph (Model Type No: 81010, ©Brabender® OGH Duisburg, 1979, Germany) to study the water hydration and mixing characteristics of each of the fortified and unfortified dough under investigation. The following parameters were determined by farinograph instrumemt: water absorption (%), arrival time (min.), dough stability (min.), mixing tolerance index (B.U.) and degree of softening (B.U.) as described in the AACC method no. 54-21 (AACC, 1995).

6.2. Extensograph test

Extensograph test was carried out according to the method described in the AACC method no. 54-10 (AACC, 1995) to measure the elastic properties of the fortified and unfortified dough. An extensograph (Model Type No: 81010, ©Brabender® OHG, Duisburg, 1979, Germany) was used to measure the following parameters; Extensibility 'E' (mm), Resistance to Extension 'R' (B.U.), Proportional Number (R/E ratio) and Dough Energy (area under the curve, cm^2) of each of the fortified and unfortified dough under investigation

7. Preparation of the bread

Egyptian balady flat bread was prepared according to the common method described in the manual of wheat and flour testing methods. About 85 g of wheat flour (extraction 82%), 1.5g compressed yeast, 1.0g salt, in addition to 65–70g water, enough to make sticky dough of 14% moisture basis, were used. Flour was added to the yeast suspension and the salty solution, mixed to the optimum dough development stage and then placed in a fermentation cabinet at 28 °C and 85% relative humidity for about 40 to 50 min. After removal from the fermentation cabinet, the dough was divided into equal pieces and formed into balls by hand. Pieces were left to rest for 10–20 min and then dusted with flour and compressed by hand. The dough pieces were returned to the fermentation cabinet and proofed for 30–45 min. Finally, dough pieces were baked in an oven on 450–500 °C for 1 to 2 min**.**

8. Quality evaluation of flour

The prepared bread samples, fortified with different Percentages of flour (wheat and cassava), were subjected to different evaluation (physio-chemical and sensory) to select the best formula that maintained the highest quality to the final product.

8.1. Physical (objective) evaluation of balady bread

Percentage change in weight after baking (%) was determined for balady bread according to the following equation:

$$\%\ Change\ in\ weight = \frac{wt.\ before\ baking(g) - wt.\ after\ baking(g)}{wt.\ before\ baking(g)} \times 100$$

Specific volume (volume to mass ratio) was calculated using the following equation:

$$Specific\ volume\ (cm^3/g) = \frac{Loaf\ volume}{Loaf\ weight}$$

Percent change (%) for weight, volume and specific volume of the fortified products were calculated as a percentage relative to the control values according to the following equation:

$$\%\ Relative\ to\ control = \frac{Fortified\ value}{Control\ value} \times 100$$

8.2. Determination of freshness degree of balady bread

Product degree of freshness (mm/sec) before and after storage (for 15 days at 25°C) was measured by using penetrometer apparatus, model H-1240 with serial number of 99101240 specs: Ast M, Humboldt MFG, Co., U.S.A. according to (Penfield and Campbell, 1990) at Nutrition and Food Science Laboratory, Food Technology Department, National Research Centre in Dokki, Cairo, Egypt. The method was based on determination of the distance (mm) a cone penetrates a sample (balady bread product) during a defined period of time (sec) as indication for product freshness

8.3. Color evaluation of balady bread

Color of exterior crust (outer surface and outer side) and interior crumb of fortified and control balady bread product were measured according to Hunter, (1975).

Color analysis of wheat flour, cassava flour under investigation was carried out at Food Technology Department, National Research Centre in Dokki, Cairo, Egypt. Hunter a*, b* and L* parameters were measured according to (Hunter ,1975) by using a spectro-colorimeter (Tristimulus Color Machine) with CIE lab color scale (Hunter, Lab Scan XE - Reston VA, USA) I calibrated with a white standard tile of Hunter Lab color standard (LX No. 16379);X=77. 26, Y=81.94 and Z=88.14 (L*=92.43; a*=-0.86; b*=-0.16) where L*=Lightness, a* =redness, b*=yellowness) Hue angle (tan-1 b/a) and Saturation index [√ a2 + b2] were also calculated

8.4. Sensory evaluation of balady bread

Sensory evaluation was carried out by 10 panelists from staff members in both of Environmental Research Institute of Sadat University ,and Food Technology Department, National Research Centre in Dokki, Cairo, Egypt, using score sheet of 10-points as presented in appendix "I" (1= lowest quality to 10= highest quality) according to Klein, (1984) and Penfield and Campbell, (1990). Bakery products (pan bread) were evaluated for: appearance, color (internal/external), cell uniformity taste, odor and overall acceptability. The results for each characteristic were calculated as mean value, analyzed statistically and tabulated**.**

8.5. Nutritive evaluation of balady bread

Balady bread samples with different percentages of flour (wheat and cassava) as flour were chemically analyzed to determine their nutritive value. Moisture and crude ash were determined according to the method reported by Fennema *et al*., (1996). Crude protein, fat and fiber were determined according to the methods described in AOAC, (2005), but total carbohydrates were calculated by difference.

Statistical analysis

The statistical analysis was carried out using SAS, PC statistical software for balady bread samples evaluation results: tenderness values and sensory evaluation were expressed as (mean ± SD). Data were analyzed by one way analysis of variance (ANOVA).The differences between means were tested for significance using least significant difference test (LSD) at $(P < 0.05)$ according to SPSS, (1986).

Results and Discussion

1. Chemical composition of wheat flour, cassava flour

Chemical compositions of wheat flour (WF) and cassava flour (CF) were seen in Table (1). Regarding the protein content, the result shows that Wheat flour contains more protein than cassava flour (11.75% and 1.52%, respectively). Same findings detected by other investigators (Amira *et al*., 2019). Protein content of cassava flour by the previous study was (2.1%) (Amira *et al*., 2019). Protein content of cassava flour by the previous study was (2.1%) which was found to be somehow Close to the value detected by the present study. The variation in protein values could be related to several reasons; among these are the preparing conditions, method used for protein determination and environmental factors associated with planting such as choice of species and varieties of the crop, the soil, fertilizers, irrigation system, climate, etc. Variation in the relative proportions of the individual proteins in different varieties could definitely alter the nutritive value of the total protein**.**

Table 1: Wheat flour formulas (%) and cassava flour

Component (%)	1 (Control)	2	3	4	5
Wheat flour	100	0.17	0.34	0.51	0.637
Cassava flour	--	0.68	0.51	0.34	0.212

1. Control sample 100% wheat flour
2. 20% cassava flour + 80% wheat flour
3. 40% cassava flour + 60% wheat flour
4. 60% cassava flour + 40% wheat flour
5. 75% cassava flour + 25% wheat flour

Table (2) demonstrates that the high level of fat content was found for wheat flour (2.59%) followed by cassava flour the (0.83%). On the other hand moisture content showed convergence percentage in wheat flour (12.72) and cassava flour (12.41). Concerning crude fiber content, obtained values were (1.25) for the Wheat Flour, (1.73) for cassava flour. The ash content in wheat flour was low (1.46) but increased in cassava Flour, The protein content in cassava flour was low (1.52) but increased in wheat flour (11.75) and this was also found by FAO, (2007), which proved that cassava is very low in protein contents. Table (2) also showed that cassava flour recorded the highest Carbohydrate percentage (94.30) where cassava flour is a rich source of carbohydrate. Whereas, a carbohydrate percentage registered (82.93) in wheat flour.

Table 2: Chemical composition (% on wet weight basis) of wheat flour, cassava flour.

Samples	Protein	fat	Moisture	Ash	Carbohydrate	Fiber
Wheat flour	11.75[a]	2.59[a]	12.72[b]	1.46[b]	82.93[b]	1.25[b]
Cassava flour	1.52[b]	0.83[b]	12.41[a]	1.62[a]	94.30[a]	1.73[a]

*Means values in the same row showed the same super script small letter is significantly different ($p \geq 0.05$).

Farinograph is used to determine flour strength and to predict processing characteristics like water absorption and mixing time. The results of farinograph test for different percentages from (wheat and cassava) dough, Table (3).

Water absorption (%) of sample (control) showed an increase as compared to that of the different percentages from (wheat and cassava) samples: (63.00 for control sample and 62.2 for 20% cassava flour). Also, percentages 40%, 60% and 75% needs less water (62%, 56.5% and 54.5% respectively).

Dough development time (min.) increased whenever increased percentage of cassava flour, was dough development time for a control sample and 20% percentage 1min. While it was the dough development time for samples 30%, 40% and75% (1.5min, 7min, 29min respectively) where Dough development time has increased by adding cassava flour.

Whereas dough stability decreased by 3 min for percentages 20% cassava flour (6.5) while control sample was (9.5) min.

While it was decreased by (4.5min, 3.5min, 7min) for (40%, 60%, 75% respectively). Due to weakening of the gluten network configuration during the kneading.

Table 3: The effect of replacing different percentage of wheat flour with cassava flour on farinograph properties.

Parameters	1 (Control)	2	3	4	5
Water absorption (ml)	63.00	62.2	62	56.5	54.5
Dough development Time (min)	1	1	1.5	7	29
Dough stability (min)	9.5	6.5	5	6	2.5
Dough weakening(B.U.)	50	100	140	90	240
Mixing tolerance index(B.U.)	30	90	120	100	240

1. Control sample 100% wheat flour
2. 20% cassava flour + 80% wheat flour
3. 40% cassava flour + 60% wheat flour
4. 60% cassava flour + 40% wheat flour
5. 75% cassava flour + 25% wheat flour

Extensograph is useful in determining gluten strength and bread making characteristics. Results for extensograph characteristics of dough from wheat and cassava flour are presented in Table (4).

Dough resistance to extension (B.U.) ´elasticity' values was found to be greater in control sample (350) and 75% cassava flour(330) compared to that of 20%cassava flour(180) and 60% cassava flour (165), The lowest values among all the prepared samples were 40%cassava flour(80).

However, Dough extensibility (mm) was found to be greater (150 mm) in control sample and 20%cassava flour (140mm) than that of the 40%cassava flour (110mm), 60% cassava flour(80mm) and 75%cassava flour(45mm). Dough Energy (cm^2) was found to be higher in control sample (98 cm^2) than the 40% cassava flour (61 cm^2) and it was the lowest sample that contains75% cassava(22cm^2). High substitution of cassava flour reduces elasticity properties of wheat flour dough making the dough incapable of retaining the gas emanating from fermentation (Giami, 2004).The same findings were reported by Amira *et al*. (2019) who studied the effect of cassava flour incorporation on the balady bread characteristics

Table 4: The effect of replacing different percentage of wheat flour with cassava flour on extensograph properties

Parameters	1 (Control)	2	3	4	5
Dough energy (cm²)	98	44	61	38	22
Dough extensibility (mm)	150	140	110	80	45
Dough resistance to extension (B.U.)	350	180	80	165	330
Proportional Number	2.3	1.28	0.727	2.06	7.3

1. Control sample 100% wheat flour
2. 20% cassava flour + 80% wheat flour
3. 40% cassava flour + 60% wheat flour
4. 60% cassava flour + 40% wheat flour
5. 75% cassava flour + 25% wheat flour

Results in Table (5) show that dough fermentation time (1st and 2nd) did not affected by fortification with flour mixture of cassava flour and wheat flour than that of the control samples.

Specific volume was found to be greater in bread with 75% cassava flour (3.0) as compared to bread control sample (2.3).

However, Percentages of Specific volume of 40% casava flour (2.20) and 60% cassava flour (2. 20) were similar with control sample.

The functional properties of the balady bread from (wheat flour and cassava flour) are presented in Table (5). Data indicated that the density of A percentage 40% (0.454) of balady bread (wheat flour and cassava flour) was slightly higher than the percentage 60% (0.452) while the rate of 75% was the lowest in the samples (0.33), and the density of the control (0.42).

Table 5: Physical evaluation of balady bread from different percentage of wheat flour with cassava flour

Physical Parameters	1 (Blank)	2	3	4
Weight before baking	85g	85g	85g	85g
Weight After first fermentation	150	160	150	150
Weight after baking	140	145	150	170
The first fermentation period	45min	45min	45min	45min
The second fermentation period	20min	20min	20min	20min
specific volume cm^3/g	2.327	2.20	2.209	3.016
Density g/ml	0.42	0.45	0.45	0.33

1. Control sample 100% wheat flour
2. 40% cassava flour + 60% wheat flour
3. 60% cassava flour + 40% wheat flour
4. 75% cassava flour + 25% wheat flour

Degrees of Tenderness (mm/sec) results of balady bread prepared with wheat flour and cassava flour initial time after baking and upon storage period for up to 15 days at temperature (0°C) are presented in Table (6). The results of the present study indicated that at initial time (after baking) degree of tenderness (freshness) after baking decreased (361mm/sec) significantly in bread fortified with 75% cassava flour, while it increased(381 mm/sec) in bread fortified with 40% cassava flour as compared to control sample. In study done by Amira *et al*., (2019) reported that the control bread exhibited good crumb structure than the casava breads. After 3 days of storage, there were noticeable decreases in degree of tenderness of bread fortified with 60% cassava flour and 75%cassava flour (353 and 350 mm/sec, respectively) as compared to other fortified samples and control. Upon storage period for 7 days at room temperature, there was a significant decrease in degree of freshness of fortified bread with 60% cassava flour and 75%cassava flour as compared to other fortified samples and control(348 and 341 mm/sec, respectively). After 15 days of storage, there were significant decreases in degree of tenderness of all bread samples.

Table 6: Determination of freshness degree of balady bread from different percentage of wheat flour with cassava flour.

Storage time	Blank	40	60	75
Zero time After baking	371[b]	381[a]	368[b]	361[c]
3	361[b]	371[a]	353[c]	350[c]
7	358[b]	365[a]	348[c]	341[d]
10	352[b]	358[a]	341[c]	338[c]
15	348[b]	356[a]	337[c]	330[d]

*Means values in the same row showed the same super script small letter is significantly different ($p \geq 0.05$).

Color and appearance of baked product are among the important characteristics that indicate its quality acceptability. Hunter colorimeter results of unfortified and fortified bread (Table 7) show that the lightness decreased in the 50%cassava flour bread sample as compared to the control. Among all the fortified samples, lightness (L*) values of outer color of bread with 75% cassava flour (60.83) were close to that of the control (59. 86). While increased in bread samples from 100% cassava flour (65. 5) as compared to the control.

On the other hand, the redness (a*) values increased in all the bread samples upon fortification as compared to control (10.51),

Except for the samples of 40% cassava flour (9. 99) and 100% cassava flour (9. 61). The highest value was detected in bread sample fortified with cassava flour (50%cassava flour) which was found to be (14.26). Saturation index is related to a* and b* values as a degree of color intensity. Saturation index of the crust of bread samples was close to the control one (31.00), then it increases for bread samples of 75% cassava flour (34.06) and decreased for 100% cassava flour bread sample (28.83). Table (7) showed that the hue angle was close to the control one for all bread samples if compared to control sample. It ranged from 70.15 for control sample to 70.54 for 100% cassava bread sample. While decreased in bread samples of 50% cassava flour (60.81) and 10%cassava flour (67.30) as compared to the control. The highest color difference (ΔE) of the crust color was recorded for bread of 75% cassava flour and bread of 100% cassava flour (10.27 and 6.12, respectively). Therefore, from the above results, the present study showed that addition of cassava flour affected crust color of bread that tended to be dark brown as compared to the control (light brown).The redness (a*) and yellowness (b*) values of color were affected by the addition of bread of 50% cassava flour (14.26 and 25.54, respectively). It formed an orange-brown color as compared to the control bread sample.

Table 7: Hunter color values of balady bread from different percentage of wheat flour with cassava flour.

Bread sample	L*	A*	B*	A/b	Saturation index	Hue angle	ΔE
1	59.86	10.51	29.17	0.36	31.00	70.15	-
2	55.05	12.06	28.82	0.41	31.24	67.30	5.07
3	57.38	11.11	29.23	0.38	31.27	69.18	2.55
4	60.17	11.3	30.74	0.36	32.75	69.81	1.78
5	63.49	9.99	30.36	0.32	31.96	71.79	3.86
6	40.15	14.26	25.54	0.55	29.25	60.81	5.23
7	58.43	10.65	30.03	0.35	31.86	70.47	1.67
8	60.83	11.53	32.05	0.35	34.06	70.23	10.27
9	65.58	9.61	27.19	0.35	28.83	70.54	6.12

Regarding the color of the outer side, bread of 50%cassava flour sample had darker color (a* values) and lower color difference (AE) in bread of 60% cassava flour. Brightness (L*) values was higher (65.58) in bread of 100% cassava. Color browning of bakery product is usually related to such chemical reaction called (Maillard reaction), that chemical reaction involving amino groups and carbonyl groups, which are common in foodstuffs, and leads to browning and flavor production. As reported by (Fukui *et al*., 1993), maillard reaction occurs between free amino groups of protein and carbonyl groups of reducing sugars, and lead to a decrease in the availability of amino acids involved and in protein digestibility. Basic amino acids are more reactive than neutral or acid amino acids. Lysine appears to be the most reactive amino acid, owing to the fact that it has two available amino groups (O'Brien and Morrissey, 1989). Furthermore, lysine is limiting in cereals, and loss in availability would immediately result in a decrease in protein nutritional value. Lysine may thus serve as an indicator of protein damage during processing. However, arginine, tryptophan, cysteine and histidine might also be affected (Iwe *et al*., 2001).

Sensory evaluation results of balady bread samples from different percentage of wheat flour with cassava flour are stated in Table (8). Among all the prepared bread samples, the scores given (mean ± SD) to each of the evaluated characteristics (appearance, internal color, external color, layers, flavor, roundness, freshness and taste) of balady bread from 75%, 60% and 50% cassava flour, was found to be close to the control and better than that of the other fortified samples, followed by samples from 40% and30% cassava flour, followed by samples from 20% and 10% cassava flour. The present results of sensory evaluation differed with the finding of (Amira *et al*.,2019)and(Agunbiade *et al*.,2017)who stated that regarding bread quality, cassava replacement by (10%,20% and 30%) similar with technological and sensory characteristics than wheat bread. The increasing replacement (75%) resulted in crumble the breads.

Table 8: Mean values of sensory characteristics of balady bread from different percentage of wheat flour with cassava flour.

Sensory characteristics	1	2	3	4	5	6	7	8	9	L.S.D
Appearance	8.7^{a}± 1.494	9^{a}± 0.816	8.8^{a}± 0.632	9^{a}± 0.666	8.4^{a}± 0.966	8^{a}± 1.154	6.5^{b}± 1.000	3.4^{c}± 2.065	1.1^{d}± 1.197	1.092
Exterior color	8.5^{a}± 0.707	8.7^{a}± 0.483	8.7^{a}± 0.483	8.6^{a}± 0.516	8.1^{a}± 1.595	8.5^{a}± 0.849	7.9^{ab}± 1.449	6.7^{b}± 2.213	1.8^{c}± 2.149	1.222
Interior color	8.5^{a}± 0.971	8.9^{a}± 0.567	8.7^{a}± 0.483	8.7^{a}± 0.483	8.8^{a}± 0.421	8.8^{a}± 0.421	8^{a}± 1.247	6.4^{b}± 2.193	1.9^{c}± 2.282	1.267
Layers	8.8^{a}± 0.421	8.8^{a}± 0.632	8.7^{a}± 0.483	8.5^{ab}± 0.707	7.6^{bc}± 1.074	7.1^{cd}± 1.197	6.2^{d}± 1.229	4^{e}± 2.309	0.5^{f}± 0.707	1.020
Flavor	8.7^{a}± 0.483	8.6^{a}± 0.699	8.4^{ab}± 0.699	7.6^{abc}± 1.505	7^{bc}± 2.309	6.5^{cd}± 2.758	5.2^{de}± 2.485	3.7^{e}± 1.946	0.5^{f}± 0.948	1.590
Roundness	8.7^{a}± 0.674	8.8^{a}± 0.421	8.7^{a}± 0.674	8.7^{a}± 0.483	8.7^{a}± 0.674	8.3^{a}± 0.823	6.7^{b}± 2.162	4.4^{c}± 2.270	0.5^{d}± 1.251	1.133
Softnex	8.7^{a}± 0.674	8.5^{a}± 0.849	8.5^{a}± 0.849	8.4^{ab}± 0.699	7.7^{ab}± 1.159	7.4^{b}± 1.173	5.7^{c}± 1.251	5.2^{c}± 1.873	0.7^{d}± 0.823	1.003
Taste	9^{a}± 0	8.7^{a}± 0.483	8.3^{ab}± 0.823	7.6^{abc}± 1.577	7^{bcd}± 2.357	6.5^{cd}± 2.718	5.4^{d}± 2.633	3.7^{e}± 2.496	0.5^{f}± 0.707	1.667

*Means values in the same row showed the same super script small letter is significantly different (p≥0.05).

Chemical composition (%) of balady bread samples from different percentage of wheat flour and cassava flour is presented in Table (9). Results indicated that protein decreases gradually in all bread samples by Increase the percentage of cassava flour in bread as compared with that of the control. So whatever, the higher the percentage of cassava flour in bread, the lower the protein. Protein levels ranged from (11, 88 % to 10, 29%) with the highest ratio recorded for the control sample and the lowest in the bread sample from 75% cassava flour, and this was also found by FAO (2015), which proved that cassava is very low in protein contents (only 2.0%).cassava–wheat flour mixing showed a protein percentage of 11.10%, which is much higher than that of cassava flour alone. Therefore, proportions of wheat flour can be replaced with cassava flour in baked goods without affecting protein content. On the other hand, there was a reduction in carbohydrate and fat contents in all bread samples in comparison with the control one as following; (from 80.60 to 79.39%)and (0.84 to 0.59%) , respectively.

Table 9: Nutritive composition (%on wet weight basis) of balady bread from different percentage of wheat flour with cassava flour.

Samples	Protein	fat	Moisture	Ash	Carbohydrate	Fiber
Blank (1)	11.88^{c}	0.84^{e}	39.06^{b}	3.55^{d}	80.60^{a}	3.12^{d}
40% (2)	11.10^{c}	0.95^{f}	27.17^{b}	7.32^{d}	75.73^{a}	4.89^{e}
60% (3)	10.89^{c}	0.59^{f}	38.71^{b}	5.96^{d}	78.92^{a}	3.64^{e}
75% (4)	10.29^{c}	0.59^{f}	38.91^{b}	5.98^{d}	79.39^{a}	3.75^{e}

*Means values in the same row showed the same super script small letter is significantly different (p≥0.05).

While there was a rise in the fiber content in all bread samples in comparison with the control one as following; (from 3.12 to 3.75%) , respectively.

From Table (9), it could be also observed that ash content increased in sample 2 (7.32 %) and decreased in the control sample (3.5%), While the percentage was in sample 3 and 4 (5.96 and 5.98%), respectively,

Moisture content ranged from 39.06 to 38.91% with the highest value in control sample and lowest in sample (4). This decrease of moisture could be due to the influence of decrease levels of protein on water-holding capacity, taking into consideration the moisture content of cassava flour similar to wheat flour.

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