

ASSESSMENT OF CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES OF GLUTEN-FREE COMPOSITE FLOUR AND QUALITY ATTRIBUTES OF PAN BREAD

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By

E. A. A. Abd Rabou

Home Economics Department, Faculty of Specific Education, Aswan University, Egypt.

ABSTRACT

Gluten-free composite flour was prepared by substituting rice flour by chickpea or white corn at different levels. The chemical composition and physical properties were studied. Furthermore, the effect of different levels of water on pan bread quality were studied. The results showed that increasing the replacement levels of rice flour with chickpea or white corn, increased protein, fat and ash. Moreover, water or oil absorption capacity of both composite flours increased. Bulk density of rice-chickpea increased, but decreased in rice-white corn composite flour. In addition, the initial gelatinization temperature of rice-chickpea composite flour increased, but decreased with rice-white corn. Moreover, the gelatinization temperature and maximum gelatinization of both types of composite flour decreased. Also, increasing levels of the used water lead to decreasing the baking loss of pan bread containing 20% chickpea and that contained 67% white corn and specific volume of pan bread containing 20% chickpea flour also gradually decreased, but increased in pan bread containing 67% corn. Regarding sensory properties, it improved in both types of pan bread, specially taste and odor. Generally, both chickpea and white corn replacing rice flour can improve the nutrition value and physical properties of composite flour. Also, increasing the water levels can improve the physical properties and some sensory properties of pan bread.

Key words: *Composite flour, chickpea, rice, white corn, pan bread.*

1. INTRODUCTION

Demanding Gluten-free products increased due to the growing number of people who suffer celiac disease, and thereby need gluten-free diet (Padalino *et al.*, 2016). So, all the products prepared from wheat, rye, barley, and oat must be replaced by corn, rice, millet equivalents and various types of starch (corn, rice and potato) or appropriate mixtures (Lazaridou *et al.*, 2007 and Hegazy *et al.*, 2009). The use of composite flour for bread making is gradually gaining prominence worldwide due to some economic and nutritional reasons (Yaseen *et al.*, 2010 and Roshid *et al.*, 2016). Composite flour can be defined as a mixture of several flours, starches and other ingredients obtained from roots, tubers, cereals and legumes with or without the addition of wheat flour in bakery and pastry products (Shittu *et al.*, 2007 and De la Hera *et al.*, 2013).

Rice flour is one of the most suitable flours for baking gluten-free products due to its hypoallergenic properties, soft taste, white color, low sodium content, easily digestible carbohydrates and mild flavor and pale appearance

(Lopez *et al.*, 2004, and Mirzaei and Movahed, 2013). Legumes with high protein content are widely used as composite flour in the production of bakery products (Mishra and Chandra, 2012). So, chickpea should be used as an ingredient in the bakery industry such as functional and healthy food formulations as biscuits, snack foods, bread, breakfast food, and cakes (Youssef, 2015). Also, maize (corn) flour could be utilized as an ingredient for the production of gluten-free bread; it is suitable for class consumption, together with rice. However, its use in such formulations is usually limited, probably due to the distinctive flavor and intense yellow color (Schober *et al.*, 2010 and De la Hera *et al.*, 2013).

Bread is considered an important food product in most regions of the world. Therefore, it should contain required nutritional value and curative properties (Mirzaei and Movahed, 2013 and Mollakhalili Meybodi *et al.*, 2015). Hydrocolloids (such as xanthan gum, guar gum and pectin) are added to naturally gluten-free flour to mimic the viscoelastic properties of gluten and to improve sensory properties, structure, and shelf-life of these

products (Moore *et al.*, 2004; Lazaridou *et al.*, 2007). For obtaining high-volume and soft crumb texture bread, different non gluten proteins as soybean, pea, egg, and dairy proteins have been included in gluten-free formulations to provide structure and gas-retaining properties of the dough and to improve simultaneously the nutritional quality structure, mouth feel, acceptability and shelf life (Korus *et al.*, 2006 and Mariotti *et al.*, 2009).

Gluten-free bread dough is a more fluid system similar to that of cake batter due to the lack of a gluten matrix (Gallagher *et al.*, 2004; Moore *et al.*, 2004 and Torbica *et al.*, 2010). The batter becomes meringue-like in fermentation. Thus, the walls of the bubbles in the rising batter, should be more fragile than those in wheat dough. It has been reported that a mixture of cereal flour improves the quality of gluten-free bread (Sciarini *et al.*, 2010). So the quantity of added water is considered very important for the distribution of the dough materials, their hydration

prepared by replacing rice flour by white corn at the ratios of 17, 33, 50, and 67%. Afterwards, studying the effect of five levels of water, *i.e.*, 70, 80, 90, 100 and 110 %, based on flour mass, on quality attributes such as physical and sensory properties of two types of composite flour where the first one contained 20% chickpea flour, and the second contained 67% white corn flour.

2. MATERIALS AND METHODS

2.1. MATERIALS

Peeled roasted chickpea, rice flour, white corn flour, salt, full fat milk powder, dry yeast powder, sugar, Arabic gum, egg, and oil were obtained from the local markets of Aswan city, Egypt.

2.2. METHODS

2.2.1. Preparation of composite flour

Peeled roasted chickpea was milled by house mincer. And rice-chickpea or rice-white corn composite flour was prepared by replacing rice flour by chickpea or white corn flour according to the formula shown in Table (1).

Table (1): Formula of composite flour.

Constituents	Rice- chickpea composite flour				Rice -white corn composite flour			
	5% CHF	10% CHF	15% CHF	20% CHF	17% WCF	33% WCF	50% WCF	67% WCF
Rice flour	95	90	85	80	83	67	50	33
White corn flour	-	-	-	-	17	33	50	67
Chickpea flour	5	10	15	20	--	--	--	--

CHF: Chickpea flour. WCF: white corn flour.

and the gluten protein network development (Ahmed, 2013).

For these reasons, the present investigation was conducted to study the quality attributes of two composite flours. The first one was prepared by replacing rice flour by chickpea flour at the ratios of 5, 10, 15 and 20% and the second one was

2.2.2. Preparation of pan bread from rice-chickpea and rice-white corn blends

Pan bread ingredients were prepared according to the formula shown in Table (2). Sugar and yeast powder were dissolved in 50–60 ml of warm water (35°C), then mixed together and spent about 5 minutes to activate the yeast. All dry and wet

Table (2): Formula of pan bread.

Ingredient (g) Products	Rice pan bread with 20% chickpea flour					Rice pan bread with 67 % corn flour				
	70% water	80% water	90% water	100% water	110% water	70% water	80% water	90% water	100% water	110% water
80% RF- 20% CHF	250	250	250	250	250	-	-	-	-	-
33% RF -67% WCF	-	-	-	-	-	250	250	250	250	250
Sugar	7	7	7	7	7	7	7	7	7	7
Full fat milk powder	20	20	20	20	20	20	20	20	20	20
Oil	30	30	30	30	30	30	30	30	30	30
Hen egg (whole, fresh)	50	50	50	50	50	50	50	50	50	50
Salt	2	2	2	2	2	2	2	2	2	2
Yeast powder	5	5	5	5	5	5	5	5	5	5
Arabic gum	3	3	3	3	3	3	3	3	3	3
Water	175	200	225	250	275	175	200	225	250	275
Water as mass flour %	70	80	90	100	110	70	80	90	100	110

CHF: Chickpea flour. RF: Rice flour . WCF: white corn flour.

ingredients were mixed with active yeast for 5 minutes at 35°C. The batter was put in a metal pan, covered with wet cloth and left in a warm place at 35°C to ferment for 40 minutes and baking in a hot oven at 180°C for 30-40 minutes. Finally, all pan bread samples were cooled at room temperature (30°C) and packed in low-density polyethylene bags for further analysis.

2.2.3. Chemical analysis

Moisture, protein, ash and fat of flour and its blends were determined according to the methods described by A.O.A.C. (2005). Total carbohydrates were calculated by difference as following:

Carbohydrates % = 100 - (moisture % + protein % + fat % + ash %).

2.2.4. Physical properties of flour and its blends

2.2.4.1. Bulk and packed density determination

The bulk density and packed density of rice, white corn, chickpea flour and its blends were determined as the methods described by Mpotokwane *et al.*, (2008). The sample (50 g) was put into a 100 ml graduated cylinder and tapped 20-30 times. The bulk density was calculated after tapping as weight per unit volume of the sample. Also, packed density was calculated after the pressed sample by the rubber piston (a rubber rod with a rubber plug) as weight per unit volume of the sample.

2.2.4.2. Water absorption and oil absorption capacity

Water and oil absorption capacity of rice, white corn, chickpea flour and its blends were determined according to methods described by Oyeyinka *et al.*, (2013).

2.2.4.3. Amylograph characteristics

Amylograph characteristics as initial gelatinization temperature (IGT) the gelatinization temperature (GT), and maximum gelatinization (Max G) of rice, white corn flours, and its blends were determined according to A.A.C.C., (2000) by using Amylograph-E (Brabender Gmb H&Co. KG, Duisburg, Germany) at rheological Lab, Department of Bread And Dough, Egyptian Baking Technology Center, Elharm, Giza, Egypt.

2.2.5. Physical properties of pan bread

Weight (g) and volume (cm³) of the resulted loaves of pan bread samples were measured by the scale and replaced displacement method according to A.A.C.C., (2000). Specific volume (cm³/g) was calculated by dividing loaf volume by its weight.

2.2.6. Sensory properties of pan bread

All pan bread samples were evaluated for crust color, crumb color, texture, cell distribution, taste, odor and general appearance according to method of Gujral and Rosell (2004).

2.2.7. Statistical analysis

All data were analyzed using the software, statistical package for social science (SPSS) version 17.00 SPSS Inc., Chicago, IL, USA at the 0.05 level. The results were expressed as means ± standard deviation (SD). Data were analyzed by using one-way analysis of variance (ANOVA) for continuous variables. according to SPSS, (2008). P values <0.05 were considered to be statistically significant.

3. RESULTS AND DISCUSSION

3.1. Chemical composition of rice, chickpea, white corn flours and its blends

The results presented in Table (3) showed the chemical composition of rice, chickpea, white corn flours and its blends. The results showed that chickpea had the highest contents of protein, fat and ash followed by white corn then rice flour respectively. So, as increasing the levels of replacing rice flour by chickpea or white corn flour, protein, fat, and ash contents were gradually increased, but moisture and carbohydrates were decreased. The results of chemical composition of rice and white corn flour confirmed those of Wani and Kumar (2015).

Besides, the chemical composition of white corn flour was in agreement with that of Hussein *et al.* (2013) and Begum *et al.* (2013). The results of chemical composition of chickpea flour were in agreement with those of Wani and Kumar (2014) and Man *et al.* (2015).

All the results of the effect of adding chickpea flour to rice flour are in agreement with those of Alajaji and El-Adawy (2006), Izembaeva *et al.*, (2013) and Man *et al.* (2015). They reported that a legume, in general, especially chickpea flour is a good source of proteins, carbohydrates, several water soluble vitamins, and minerals. Legumes, in general, make a major contribution to human nutrition. It could be an ideal ingredient for improving the nutritional value of bread and bakery products.

3.2. Physical properties of rice, chickpea, white corn flours and its blends

The results presented in Table (4) showed the physical properties of rice, chickpea, white corn flours and its blends. These results indicated that bulk density values of rice-chickpea blends were gradually increased, but it were slightly decreased in rice -white corn flour blends as replacing levels were increased.

These results might be due to higher bulk density of chickpea flour compared to rice flour and white corn flours compared to rice flour, but it

Table (3): Chemical composition of rice, chickpea, white corn flours and its blends (on dry weight).

Constituents	Moisture (%)	Dry matter (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Rice flour	8.59±0.04b	91.41±0.04b	6.21±0.03c	1.22 ±0.02c	0.33± 0.01c	92.24±0.06a
White corn flour	10.95±0.07a	89.05±0.07c	11.04±0.05b	3.22±0.02b	1.89±0.08b	83.85±0.09b
Chickpea flour	7.58±0.06c	92.42±0.06a	24.56±0.02a	7.52±0.03a	3.74±0.06a	64.18±0.03c
P<	****	****	****	****	****	****
Rice-chickpea composite flour						
5% chickpea flour	8.54±0.02a	91.46±0.02c	7.13±0.04d	1.54±0.03d	0.50±0.02d	90.83±0.06a
10% chickpea flour	8.49±0.04ba	91.51±0.04b	8.05±0.07c	1.85±0.03c	0.67±0.05c	89.43±0.10b
15% chickpea flour	8.44±0.05b	91.56±0.05ba	8.96±0.04b	2.17±0.02b	0.84±0.02b	88.03±0.08c
20% chickpea flour	8.39±0.03c	91.61±0.03a	9.88±0.02a	2.48±0.03a	1.01±0.03a	86.63±0.02d
P<	***	***	****	****	****	****
Rice-white corn composite flour						
17% White corn flour	9.80±0.01d	90.20±0.01a	7±0.1d	1.52±0.02d	0.58±0.02d	90.9±0.06a
33 White corn flour	10.04±0.05c	89.96±0.05b	7.8±0.02c	1.88±0.03c	0.84±0.04c	89.48±0.03b
50 White corn flour	10.27±0.04b	89.73±0.04c	8.61±0.04b	2.22±0.05b	1.1±0.01b	88.07±0.07c
67% White corn flour	10.5±0.02a	89.5±0.02d	9.42±0.02a	2.55±0.03a	1.36±0.03a	86.67±0.06d
P<	****	****	****	****	****	****

Each record is a mean value of three replicates and is followed by the standard deviation: means in the same column with different superscript differed significantly at p< 0.05. .P< 0.05. ..P< 0.01. ... P< 0.001. P< 0.0001.

Table (4): Physical properties of rice, chickpea white corn flours and its blends.

Constituents	Bulk density (g/ml)	Packed density(g/ml)	Water absorption capacity (WAC) ml/g	Oil absorption capacity (OAC) ml/g
Rice flour	0.84±0.03b	0.74±0.01a	0.81±0.02c	0.57± 0.01c
White corn flour	0.76±0.03c	0.67±0.01b	1.04±0.04b	0.87±0.03b
Chickpea flour	1.05±0.01a	0.59±0.01c	1.89±0.02a	1.16±0.01a
P<	****	****	****	****
Rice- chickpea composite flour				
5% chickpea flour	0.83±0.04c	0.74±0.04a	0.86±0.02d	0.59±0.05d
10% chickpea flour	0.86±0.03b	0.71±0.03b	0.92±0.05c	0.62±0.01c
15% chickpea flour	0.88±0.01a	0.69±0.01c	0.97±0.01b	0.65±0.02b
20% chickpea flour	0.89±0.02a	0.68±0.05c	1.03±0.04a	0.68±0.01a
P<	****	****	****	****
Rice- corn composite flour				
17% White corn flour	0.82±0.01a	0.73±0.01a	0.83±0.01c	0.61±0.01d
33 White corn flour	0.81±0.03ba	0.72±0.07a	0.87±0.07bc	0.65±0.01c
50 White corn flour	0.80±0.04ba	0.71±0.03ba	0.92±0.01ba	0.71±0.01b
67% White corn flour	0.79±0.03ba	0.69±0.05b	0.96±0.06a	0.77±0.02a
P<	**	**	.	**

Each record is a mean value of three replicates and is followed by the standard deviation: means in the same column with different superscript differed significantly at p< 0.05. .P< 0.05. ..P< 0.01. ... P< 0.001. P< 0.0001.

was low in white corn flour compared to rice flour. So, packed density of two types of flour blends was decreased by increasing replacing levels. The results of bulk density of white corn flour confirmed those of Abiose and Ikujenlola (2014).

Water absorption capacity (WAC) and oil absorption capacity (OAC) of chickpea flour were higher than those of rice or white corn; also they were more in white corn flour compared to rice flour. So, WAC and OAC of two types of flour blends increased by increasing levels of chickpea

or white corn flour. These results may be due to the fact that white corn or chickpea flour has high content of protein compared to rice flour. Protein enhances the interaction between the binding forces which in turn increases the gelling ability of flour as found by Lawal *et al.* (2004) and Shad *et al.* (2013). It could be also due to the fact that chickpea flour contained soluble fiber as reported by Akubor and Badifu (2004). Also, chickpea flour contains several hydrophilic components, such as polysaccharides, which have a high WAC

according to Kaur and Singh (2005). Also, the results of rice- chickpea flour blends are in agreement with those of Ionescu *et al.* (2009) and Fenn *et al.* (2010). They found that the increase of utilization of legumes in flour blends such as chickpea flour and protein concentrates displayed good water and oil absorption capacities, protein solubility and emulsifying capacity. Also, all these results are in agreement with those of Wani and Kumar (2014) and (2015).

3.3. Amylograph characteristics of rice, white corn flours and its blends

Data in Table (5) showed the amylograph characteristics of rice, white corn flour and its blends. The initial gelatination temperature (IGT) of rice- chickpea flour blends was increased compared to rice flour. On the other hand, the IGT of rice flour was lower than that of white corn flour, but IGT values of rice-white flour blends were increased compared to rice flour. The result of IGT of rice flour was accoreding with those of Wang *et al.*, (2010). They reported that the IGT of rice flour were 53.3-58°C. The result of IGT of corn flour agreed with those of Malumba *et al.* (2009). They found that IGT of white corn were 73-80°C.

The gelatinization temperature GT of rice flour was lower than that of white corn flour. The GT of two types of composite flour was decreased by increasing the levels of chickpea or corn flour. The results of IGT and GT of flour blends may be due to the differences in the chemical composition of rice flour compared to chickpea or white corn flour as shown in Table (3). Thus, the gelling and viscosity properties of composite flour were improved by increasing the levels of substitution. These results may be due to the increasing of WAC as the contents of protein and fibre in rice-chickpea or white corn composite flours were increased. These results confirmed those obtained by Balasubramanian *et al.* (2012).

Maximum gelatinization Max G of rice flour was more than that of white corn flour. It was decreased by increasing chickpea or white corn flour levels. Finally, according to the amylograph characteristics of flour blends, it could be used these composite flours in many baked products as cake and pan bread. These results are in agreement with those of Ammar and Abed El-Razik (2013). Moreover, these results confirmed those of Sajilata *et al.* (2006). They found that the gelatinization properties of starches depend on its type, granular structure, botanical origin, and amylose/ amylopectin ratio.

3.4. Physical properties of pan bread

Bread development without gluten has involved the use of diverse ingredients and additives with the purpose to imitate the viscoelastic properties of the gluten and consequently to obtain bread-like products (Gallagher *et al.*, 2004). Also, water absorption is considered an important characteristic of flour. High water absorption is required for good bread characteristics which remain soft for a long time (El-Sisy *et al.*, 2014). Thus, rice with 20% chickpea and rice with 67% white corn composite flour were used to prepare pan bread with high quality.

Data in Table (6) showed the effect of increasing water levels on the physical properties of rice pan bread. Baking loss of rice-chickpea pan bread was decreased, but it was increased in rice-white corn by increasing the levels of water. So, weight of rice-white corn pan bread was decreased, but, it was increased with rice-chickpea pan bread. These results may be due to WAC of rice-chickpea composite flour, which was higher than that of rice-white corn as found in Table (4). As a result, the optimum absorption represents the maximum amount of water, as a percentage of the flour weight that will produce a high yield of bread during the baking process as reported by Edmund and Perry (2008).

Furthermore, the increasing of water content of the dough increases the amount of free water in the bread dough, raising the water content of the finished product as reported by Gil *et al.* (1997). Also, the result of pan bread weights agreed with those of Pühr and Appolonia (1992). They found that the total bread weight of the high-absorption flour was greater than the weight of the low absorption flour.

The volume of rice-chickpea pan bread gradually decreased, but its weight increased. So, the specific volume (SV) decreased by increasing the levels of water. thus, the highest SV was found at the 70% water level. This might be due to the modification of viscoelastic properties, as a result of competition for the water availability between the protein of chickpea and starch which resulted in a delay in starch gelatinization and, therefore low expansion in the gelatination as reported by Wani and Kumar (2015). But the volume of rice-white corn pan bread samples increased, but weight decreased by increasing water levels. So, the specific volume SV gradually increased, the highest level recorded at 100% water, but it decreased at 110% water. These results agreed with those of Różyło *et al.* (2015). Also, the

Table (5): Amylograph characteristics of rice, white corn flours and its blends.

Constituents	Initial gelatination temperature (IGT) °C	Gelatinization temperature (GT) °C	Maximum gelatinization (Max G) AU
Rice-chickpea composite flour			
Rice flour	58	85	2960
5% chickpea flour	63	84	2900
10% chickpea flour	63	79	2700
15% chickpea flour	69	78	2520
20% chickpea flour	69	76	2390
Rice-white corn composite flour			
White corn flour	75	93	1320
17% White corn flour	69	87	2040
33 White corn flour	69	86	1280
50 White corn flour	69	87	1210
67 White corn flour	68	86	1040

AU: Brabender amylograph units.

Table (6): Physical properties of pan bread.

Constituents	Baking loss(g)	Volume (cm3)	Wight (g)	Specific volume (cm3/g)
Rice pan bread with 20% chickpea flour				
70% water	26.35±0.05a	895.375±2.88a	378.25±1.93e	2.37±0.05a
80% water	23±0.1b	890.625±1.19ba	385±2d	2.31±0.01a
90% water	21.4±0.05c	883.125±1.01b	393±2.65c	2.25±0.02b
100% water	17.62±0.05d	868.75±1.87c	411.81±0.73b	2.1±0.03c
110% water	14.58±0.02e	845.48±0.50d	426.81±1.57a	1.98±0.01d
P<	****	****	****	****
Rice pan bread with 67% corn flour				
70% water	13.84±0.01e	798.52±2.82bc	430.8±1.06a	1.85±0.01c
80% water	15.5±0.04d	823.75±1.64b	422.37±1.64b	1.95±0.01cb
90% water	17.2±0.02c	847.5±0.87ba	418.25±0.90c	2.03±0.01b
100% water	20.13±0.05b	900±1.00a	400.35±2.54d	2.25±0.20a
110% water	21.1±0.1a	750±2.24c	384.5±1.80e	1.95±0.01cb
P<	****	****	****	****

Each record is a mean value of three replicates and is followed by the standard deviation: means in the same column with different superscript differed significantly at p< 0.05. *P< 0.05. **P< 0.01. *** P< 0.001. **** P< 0.0001.

highest SV was recorded for rice-chickpea pan bread compared to corn-rice pan bread, these results confirmed those of Hager *et al.* (2012) and Różyło *et al.* (2015). They found that rice bread was characterized by significantly higher in specific volumes in comparison to corn bread. These results are in parallel with those previously reported in Table (5). These results confirmed those of Herranz *et al.* (2016). They reported that supplemented of gluten-free muffins with chickpea flour resulted in lower gas retention and lower expansion of muffins and the specific volume was decreased with increasing the levels of chickpea flour.

3.5. Sensory properties of pan bread

Data presented in Table (7) showed the effect of different levels of water on sensory properties of pan bread samples. The crust color and crumb color were gradually increased in rice-chickpea

pan bread. But they were not changed with rice-white corn pan bread. These results may be due to the decrease ratio of the yellow color of carotenes than that found in chickpea flour. These results agreed with those of Mondal and Datta (2008). They reported that color development is a function of moisture content, baking temperature and time period during the baking process.

Cell distribution and texture slightly increased with increasing levels of water, but they decreased at 110% water in two types of pan bread samples. Moreover, the highest general appearance of two types of bread was found at 80% water. But, as a result of increasing level of water, general appearance slightly decreased. These results were might be due to the larger holes that found between crust and crumb when the added water is too high or proofing is extended as reported by Gómez

Table (7): Sensory properties of pan bread as affected by different levels of water.

Constituents	Crust color (10)	Crumb color(10)	Texture (10)	Cell distribution (10)	Odor (10)	Taste(10)	General appearance (10)	Average (10)
Rice pan bread with 20% chickpea flour								
70% water	7±0.47c	6.4±0.52b	7±0.47c	7.5±0.53b	6.5±0.5c	6±0.62c	6.5±0.53b	6.7±0.24c
80% water	7.6±0.52b	6.7±0.48b	7.5±0.53cb	8±0.82ba	8±0.47b	7.2±0.42b	7±0.35a	7.43±0.10ba
90% water	8±0.47ba	7±0.47ba	8.3±0.48ab	8.3±0.67a	8.4±0.52a	8.1±0.32a	6.5±0.47b	7.7±0.15a
100% water	8.1±0.32ba	7.4±0.52a	8±0.67ba	8.1±0.39ba	8.5±0.47a	8.2±0.42a	6.4±0.39b	7.843±0.18a
110% water	8.2±0.48a	7.55±0.50a	7.7±0.48b	7.8±0.35ba	8.5±0.53a	8.4±0.52a	6.3±0.48b	7.72±0.14a
P<	****	****	****	*	****	****	*	****
Rice pan bread with 67 % corn flour								
70% water	7±a	7.9±0.57a	7.2±0.42c	7.2±0.35c	6.9±0.21c	7±0.15c	6.4±0.52ba	7.126±0.07c
80% water	7.1±0.21a	8.1±0.74a	7.8±0.48b	7.9±0.32b	7.2±0.34c	7.50.21±b	7.2±0.21a	7.54±0.18b
90% water	7.2±0.42a	8.2±0.63a	8.3±0.48ba	8.4±0.52ba	7.6±0.69b	7.70.42±ba	6.7±0.42ba	7.73±0.24a
100% water	7.2±0.42a	8.3±0.48a	8.65±0.41a	8.7±0.48a	7.7±0.34ba	7.80.25±ba	6.55±0.44ba	7.845±0.08a
110% water	7.2±0.79a	8.3±0.48a	8.2±0.42ba	8.25±0.42ba	8±0.4a	7.9±0.47a	6.4±0.46ba	7.78±0.23a
P<	--	--	****	****	****	****	*	***

Each record is a mean value of ten replicates and is followed by the standard deviation: means in the same column with different superscript differed significantly at p< 0.05. *P< 0.05. **P< 0.01. *** P< 0.001. **** P< 0.0001.

and Sciarini (2015). Taste and odor were improved by increasing the water content in both types of pan bread samples. These results may be due to the ratio of bean and chickpea flour, which decreased by increasing the water content. These results agreed with those of Marco and Rosell (2008). They observed that the addition of chickpea flour causes a soar in water absorption and modify textural properties of bread. Also Ouazib *et al.*, (2016) reported that chickpea flour could be used for obtaining gluten free breads with the nutritional characteristics of the legumes and acceptable sensory characteristics.

Conclusion

Gluten free composite flour contains rice and chickpea or rice and white corn showed good chemical and physical properties. thus, it can be used to prepare pan bread with high quality. Also, the increasing level of water can improve the physical properties and sensory properties of gluten free pan bread.

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تقييم التركيب الكيميائي والخواص الفيزيائية لمخاليط دقيق خالية من الجلوتين وخواص الجودة لخبز القوالب

إيمان عبد الحميد أحمد عبد ربه

قسم الاقتصاد المنزلي - كلية التربية النوعية - جامعة أسوان- مصر

ملخص

تم تجهيز مخاليط دقيق خالية من الجلوتين وذلك باستبدال دقيق الارز بنسب مختلفة بدقيق الحمص، أو الذرة البيضاء. وتم دراسة التركيب الكيميائي والخواص الفيزيائية لهذه المخاليط. وإلى جانب ذلك، تم دراسة تأثير مستويات مختلفة من الماء على الخواص الفيزيائية والحسية لخبز القوالب لتحديد مستويات الماء المناسبة للخليط الدقيق. أظهرت النتائج أنه بزيادة نسب الاستبدال في خليط الدقيق سواء لدقيق الحمص أو دقيق الذرة البيضاء بدلا من دقيق الأرز، حدثت زيادة في المحتوى من البروتين والدهون والرماد. وعلاوة على ذلك، حدث ارتفاع في معدل قدرة كل من نوعي خليط الدقيق على امتصاص الماء أو الزيت. كما حدث ارتفاع في كثافة الدقيق لخليط دقيق الارز والحمص بينما انخفضت الكثافة لخليط الارز والذرة. بالإضافة الى ذلك حدث نتيجة لارتفاع نسب دقيق الحمص والذرة ارتفاع في درجة حرارة بداية الجلتنة لخليط دقيق الارز والحمص بينما حدث انخفاض في حالة خليط دقيق الأرز والذرة. كما انخفضت درجة حرارة الجلتنة والدرجة القصوى للجلتنة لكل من نوعي خليط الدقيق. بالإضافة إلى ذلك تم دراسة مدى تأثير ارتفاع مستويات الماء على خواص خبز القوالب المحتوي على 20% حمص وخبز القوالب المحتوي على 67% دقيق ذرة، وأظهرت النتيجة انخفاض في كل من الفقد اثناء الخبز وفي الحجم النوعي لخبز القوالب المكون من خليط الارز والحمص بينما حدث ارتفاع في هذه المقاييس في حالة خبز القوالب المكون من خليط من دقيق الارز والذرة. اما بالنسبة للخواص الحسية فقد حدث تحسن في خواص الطعم والرائحة في كل من النوعين من خبز القوالب. عموما، حدث تحسن في القيمة الغذائية والخواص الفيزيائية لخليط الدقيق عند استبدال دقيق الحمص أو الذرة بدلا من الارز، كما حدث تحسن في الخواص الفيزيائية وبعض الخواص الحسية نتيجة لارتفاع نسبة الماء في خبز القوالب المصنع من خليط الدقيق.

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