Chemical Composition and Mineral Contents of Gluten Free Flat Bread Fortified with Lentil and Lupin Flour

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ABSTRACT

Most of the gluten-free bakery products consist of corn flour, rice flour and corn starch, which leads to poor in nutrients (low nutritional value), so the present research was carried out to study the effect of fortify gluten free blends consists of brown rice flour, millet flour and tapioca starch at deferent levels with lentil flour and lupine flour. Chemical composition, mineral contents, sensory evaluation and bread staling during storage at room temperature for zero, 24, 48 and 72 hours was conducted. Results indicated that lupine flour was high in protein content, fat, Ca, K and Mg, compared to lentil flour which is high in fiber and Fe. Millet flour was high in ash content and brown rice flour was high in Mn. Regarding to sensory evaluation, GF flat bread samples prepared from *(Groups A and B)* were take higher total acceptability, and they expressed as superior samples. Followed by samples prepared from *(Group E)* then *(Group C)*. The least two group's bread samples in total acceptability were *(Group F)* then *(Group D)*.

Keywords: Bread, Gluten, Lentil Flour, Lupin Flour.

INTRODUCTION

Gluten-free foods on the grocery shelves could be hard to find. Not so much, now. The Food and Drug Administration (FDA) wants you to know that foods labelled as "gluten-free". These requirements are important for people with celiac disease, who face potentially life-threatening illnesses if they eat gluten, typically found in breads, cakes, cereals, pastas, and many other foods. Some individuals may not have celiac disease but may still be sensitive to gluten. As one of the criteria for using the claim "gluten-free," *FDA* set a limit of less than 20 ppm for the unavoidable presence of gluten in foods that carry this label. *Qiu Chen et al., (2019)* investigated the effect of various milling conditions on rice flour properties. Milling speed had less effect on digestibility than did milling duration for waxy rice flour, but speed had a greater effect on the digestibility of low- and high-amylose rice flour. Dough strength was positively influenced by rice and moong flour. Higher levels of sorghum and rice tend to possess higher scores for sensory acceptability. *Encina et al., (2019)* assess the combined effect of guar gum (GG) and water content (WC) on the rheological properties of batter, and the physicochemical and textural properties of bread. Batches of gluten-free bread used a base formulation of rice (50%), maize (30%) and quinoa flour (20%), with different levels of GG (2.5, 3.0 or 3.5%) and water (90, 100 or 110%) in a full factorial design. *Lee Young et al., (2019)* study the effect of hammer milling and jet milling on germinated brown rice (GBR). The jet milling of GBR resulted in flour with different particle sizes. As the particle size decreased, the amount of damaged starch increased. The jet-milled GBR flour was slightly lower than that of the hammer-milled flour. *Rybicka et al., (2019)* found the highest nutritional benefits for protein, magnesium, potassium, calcium, zinc, iron and manganese in bread prepared with millet. The highest consumer acceptance of people on gluten-free diet was noticed for breads with quinoa and millet. *Tortoe et al., (2019)* evaluated flour of five new varieties of improved certified pearl millet. The bread showed no interactive effect between variety and replacement level with millet flour at 20%. *Bouakkadia et al., (2015)* studied the 4 legumes (peanut, soybean, sesame and lentil). Our results contribute to increase the repertoire of legume allergens that may improve the diagnosis, categorize patients and thus provide a better treatment of patients. *Li L, et al., (2019)* isolate starches of a high purity from starch-rich pea, lentil and fava bean flours. The isolated starches showed amylose contents and amylopectin branch-chain-length distributions similar to those of commercial pea starch. The desirable functionality of the starches (e.g., strong gelling ability) renders them suitable for some specific industrial applications, and further modifications can be utilized to enhance their functionality for broader use. *Xu et al., (2019)* investigated the chemical composition, thermal, pasting, and moisture adsorption properties of flour from chickpea, lentil and yellow pea, protein content increased for germinated lentil, had the highest protein content. Total starch decreased in lentil and yellow pea flour during germination, while there was no significant change in germinated chickpea flour. The highest final viscosities for chickpea, lentil, and yellow pea. *Emma Stirling, (2019*): reported that Lupin is good news for those with gluten problems and vegans, it is high in plant protein. Immunology and Allergy only around 5 per cent of children and 2 per cent of adults have food allergies and the confirmed cases of lupin allergies have been few. *Gurjral et al., (2012)* declared that celiac disease, a genetic condition experienced by 0.5–1.0% of the population worldwide, is gluten-sensitive immune-mediated enteropathy. *Stantiall, and Serventi, (2018)* reported that. There is a growing need for gluten-free bakery products. Currently, gluten-free bakery products deliver lower protein, fiber and mineral content and elevated glycemic index (GI) than gluten-containing foods. Only a mixture of rice and buckwheat flour or a low addition of either egg white or whey protein has shown potential for the improvement of both nutrition and sensory qualities. *Rybicka et al., (2019)* studied the recipe, nutritional characteristics (fat, protein, calcium, magnesium, sodium, potassium, copper, iron, zinc, and manganese). The objective of this study was to develop gluten-free flat bread to produce acceptable dough and bread properties. Flat bread was tested for physical, chemical, nutritional, sensory evaluation and staling rate also compared with refined wheat flour and commercial gluten free flour as a control.

MATERIALS AND METHODS

Raw Materials:

Brown Rice Flour (BRF), Millet Flour (MLF), Tapioca Starch (TPS), Lentil Flour (LNF), Lupin Flour (LUF), Gums Mixture [(GM) (water-soluble tamarind seed gum and agar agar)], single - action baking powder and vanilla were obtained from *Epics Group for Food Industries*, 6th of October city, Giza, Egypt.

Fresh eggs, sugar, were purchased from a local market.

Flat Bread Preparation

Flat bread was prepared according to the method of *Gularte et. al. (2012)* using different ratios of some additives, as shown in *table (1).* The processing of preparation flat bread samples was shown in *fig. (1)* and formula used to preparing flat bread was as follows:

Blended flour = 100 % - Yeast = 1 % - Salt =1 % - Oil = 5 %

Water ~ 75 - 80 %

Chemical analysis:

Chemical analysis including moisture content, ash content, crude fiber, protein content and total lipids were determined according to the method described in *A.O.A.C (2000).* Total carbohydrate was calculated by difference. The minerals elements, namely: Calcium (Ca), Iron (Fe), Zinc (Zn), Sodium (Na), Potassium (K), Magnesium (Mg) and Manganese (Mn) According to the method described in *A.O.A.C (2005).*

Sensory Evaluation *of Flat bread*

Flat bread was evaluated for Loaf rising, Crust Quality, Crust color, Crumb color, Crumb uniformity, Odor, Taste and Total Scores. The quality scoring was conducted by experienced panelists from food technology research institute (FTRI) to evaluate organoleptically the different characteristics of flat bread loaves. Score of each parameter as reported by *(Twillman and white, 1988)* as follows:

Loaf rising:10, crust quality:10, crust color:15, crumbcolor:15, crumb uniformity:10, odor:20, taste:20 and total scores:100.

Determination of staling rate for flat bread:

The staling of flat bread at different storage times 0, 24, 48 and 72 hours at room temperature, was tested by determination of alkaline water retention capacity (AWRC) according to the method of *Kitterman and Rubenthaler (1971)*

% AWRC= (Weight of tube sample after centrifuge - Weight of empty tube/ Weight of sample) 100

RESULTS AND DISCUSSION

The chemical properties of Brown rice flour (BRF), Millet flour (MLF), Tapioca starch (TS), Lentil flour (LNF), Lupine flour (LUF), Tamarind seed gum (TSG) and Agar Agar (Ag Ag) were presented in table (2).

Data given in *table (2)* it cleared that the highest flour in protein present was lupine followed by lentil and the lowest was tapioca starch. Values were 36.2, 25.8 and 0.1 % for lupine, lentil and tapioca starch respectively. Data showed that chemical properties of brown rice flour, millet flour and tapioca starch were 2.2, 4.2 and 0.0 % total fats, 2.6, 8.5 and 0.5 % fiber, 1.0, 4.1 and 0.1 % ash content respectively. These data were in agreement with those obtained by *Iuliana Aprodu and Iuliana Banu (2015), Villarino et al., (2016) and Matthew Nosworthy et al., (2018).*

Data in *table (3)* showed the mineral contents of raw materials and gums mixtuer (mg /100 g). From data, it can be observed that brown rice flour was higher in Fe, Zn, K, Mg and Mn than millet flour, but millet flour was higher in Ca and Na than brown rice flour. Values were, 1.9, 2.5, 288, 111 and 3.96 (mg/100 g) for brown rice flour. Ca and Sodium in millet flour were higher than in brown rice flour, values were 20 and 9.8 (mg / 100 g), respectively.

Regarding to fortificants (lentil flour and lupine flour), it can be noticed that lupine flour was higher in Ca, Na, K, Mg and Mn than lentil flour, values were 176, 15, 1013, 198 and 2.4 (mg / 100 g) for above-mentioned minerals for lupine flour, compared to 56, 6, 955, 122 and 1.3 (mg / 100 g) for lentil flour, respectively. From the same table it can observed that lupine flour and lentil flour were higher nutrient than all other ingredients followed by brown rice flour. On the other hand, tapioca starch was the least nutrient compare with other ingredients. When compared between two gums, it can be noticed that agar agar recorded high content of all minerals compared with tamarind seed gum. Agar agar was very high in Ca, Fe, Zn, K, Mg and Mn. These results are in agreements with *Duodu KG and Jideani AIO. (2018), Jose C Jimenez-Lopez et al., (2020) and Michael, et al., (2021).*

The main chemical composition of gluten free flat bread prepared from blends of brown rice flour, millet flour, tapioca starch and fortified with lentil flour or lupine flour at different levels, compared to flat bread prepared from wheat flour as (CONTROL–1) and commercial gluten free flour as (CONTROL– 2) are shown in table (4). Data illustrated in table (4) declared that gluten free flat bread samples prepared from millet flour with tapioca starch (group B) were higher in protein, fat, fiber and ash contents than bread samples prepared from brown rice flour with tapioca starch (group A) at all ratios of blends. Protein, fat, fiber and ash % values were 6.67, 2.53, 5.43 and 2.51 % for (group B) samples at (60% millet and 40% tapioca starch), compared to 5.11, 1.33, 1.89 and 0.65% for (group A) samples at (60% brown rice flour and 40% tapioca starch). The same trend was observed with bread samples fortified with lentil flour (group E) and (group F). On the other hand, when comparing between brown rice flour fortified with lentil flour and lupine flour (group C) and (group E), bread samples fortified with lupine flour (group E) were higher than bread samples fortified with lentil flour (group C) in protein, fat and ash content except fiber content. Protein, fat and fiber values of bread samples (group E) were 8.31, 2.19 and 3.63% at (55% brown rice flour, 35% tapioca starch and 10% lupine flour) compared to 7.27, 1.33 and 4.78% of bread samples (group C) at (55% brown rice flour, 35% tapioca starch and 10% lentil flour). These results are in agreements with_*Lee YP, et al., (2006), Viveros et al., (2007) and Hodgson et al., (2010).*

Results in table (5) showed the minerals in gluten free flat bread samples prepared from brown rice flour, millet flour and tapioca starch fortified with lentil flour and lupine flour at different levels. Data in this table, declared that prepared bread from millet flour with tapioca starch fortified with lupine flour recorded high Ca content (group F) compared with all other blended flour. Calcium values were 33, 26, 21 and 14 (mg/100g) for (groups F, E, D and C) at the same level of blends (15% tapioca) compare to 120 and 19 (mg/100g) for bread prepared from wheat flour (Control – 1) and prepared from commercial Gluten Free flour (Control – 2). Data also declared that, bread samples prepared from blend flour (group - C) was high Fe content (3.6 mg / 100g) compared with all other bread samples prepared with any other groups, followed by bread samples prepared from (group - D), Fe content recorded 3.4 (mg / 100 g). Concerning to K and Mg contents, gluten free flat bread prepared from (group – E) was higher values of mentioned minerals than all bread prepared from other groups, followed by bread prepared from (group – C).

Bread samples prepared from millet flour and tapioca starch and fortified with lentil flour (group D) were less content in Calcium, Potassium, and Magnesium than bread samples prepared from millet flour and tapioca starch fortified with lupin flour (group F).

On the other hand, Zn, Na and Mn contents were almost the same content in two groups under study.

These results may be due to the increase in these minerals in the raw materials used. These results were in parallel with *Suliburska et al., (2013), Larretxi et al., (2019) and Rogaska et al., (2020).*

The produced flat bread was evaluated for their sensory characteristics and the summery of obtained results are shown in table (6) which declared the total external properties, total internal properties and total acceptability. From results presented in table (6), it could be noticed that addition of tapioca starch to brown rice flour and millet flour (Groups A and B) lead to enhancing the external and internal properties as well as total acceptability of flat bread compared to all other group blends, and almost equal to samples prepared from wheat flour (Control-1), in addition of all GF flat bread under this study were higher scores and more acceptable than GF bread sample prepared from commercial flour (Control-2). From data illustrated in table (6), it could be noticed that, GF flat bread samples prepared from (Groups A and B) take higher total acceptability, and they expressed as superior samples. Followed by samples prepared from (Group E) which is prepared from Brown rice flour and tapioca starch fortified with lupin flour, then (Group C) which prepared from Brown rice flour and tapioca starch fortified with lentil flour. The supper samples values ranged from 91.5 to 95.5% for (Group A), followed by 91% to 93.5% for (Group B) then from 88 % to 90.5 % for (Group E) and from 87 % to 90% for (Group C), finally the least values ranged from 83% to 87% was recorded with (group D), respectively. These results are in compatible with *Feizollahi et al., (2018)) and Abrantes et al., (2019).*

Alkaline water retention capacity is (AWRC) considered as a simple and quick test to determine staling of bread. Higher values of (AWRC) means higher freshness of bread. The change in freshness characteristics of bread produced by brown rice flour or millet flour with tapioca starch and fortified with lupin flour or lentil flour, compared with the samples prepared from wheat flour (Control – 1) and commercial gluten free flour (Control – 2) were carried out after storage times of 0, 24, 48 and 72 hr. at room temperature, the obtained results are shown in Table (7). From above results, it could be noticed that flat bread prepared from brown rice flour were fresher than bread prepared from millet flour after all times of storage. Regarding to flat bread samples prepared from brown rice flour and tapioca starch fortified with lupine flour (Group E), it can be observed that these bread samples were fresher than bread prepared from brown rice flour and tapioca starch fortified with lentil flour (Group C). AWRC values of (Group E) ranged from 336 to 353 % after 24 hr. of storage, compared to 334 to 349 for bread samples fortified with lentil flour (Group C) after the same time of storage. The same trends were noticed with other storage times. Concerning the same fortifications with lupine and lentil flour with millet flour and tapioca starch (Grups F and D), the same above trends were observed at different storage times. In general, there was a gradual decrease in AWRC% (low freshness) for all different flat bread samples during storage periods, this may be due to crystallization of amylose after baking processing during bread storage, or may be due to the fact that lentil flour had a gelatinization temperature, that differs from lupine flour, and lead to effect on starch granules retrogradation. These results were agreement with *Seleem, (2000), Nassar (2017), Ammar et al., (2020) and Matsushita et al., (2020).*

CONCLUSION:

According to the previous results of the tested products, it could be concluded that, effect of adding tapioca starch to brown rice flour or to millet flour was the best additive when preparing gluten free bread, and lupin flour was better than lentil flour as a fortificants.

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Table 1: Gluten Free Flat bread blends.

	Blend No.		BRF	MLF	TPS	LNF	LUF	GM*
	CONTROL - 1		Wheat flour 72 %					
	CONTROL - 2		Gluten Free commercial flour					
A	1	UNENRICHED	20		80			0.3
	2		40		60			0.3
	3		60		40			0.3
	4		80		20			0.3
B	5			20	80			0.3
	6			40	60			0.3
	7			60	40			0.3
	8			80	20			0.3
C	9	ENRICHED WITH LNF	15		75	10		0.3
	10		35		55	10		0.3
	11		55		35	10		0.3
	12		75		15	10		0.3
D	13			15	75	10		0.3
	14			35	55	10		0.3
	15			55	35	10		0.3
	16			75	15	10		0.3
E	17	ENRICHED WITH LUF	15		75		10	0.3
	18		35		55		10	0.3
	19		55		35		10	0.3
	20		75		15		10	0.3
F	21			15	75		10	0.3
	22			35	55		10	0.3
	23			55	35		10	0.3
	24			75	15		10	0.3

BRF = Brown Rice Flour - MLF = Mellit Flour - TPS = Tapioca Starch
LNF = Lentil Flour = LUF = Lupine Flour
* GM = (TSG) 50% + (Ag) 50% -
(TSG) = Tamarind seed gum - (Ag) = Agar Agar

Table 2: Chemical composition of raw materials·

	BRF	MLF	TS	LNF	LUF	TSG	AgAg
Moisture	11.8	11.7	7.4	10.4	10.4	11.4	9.2
Protein	8.4	11	0.1	25.8	36.2	14.6	6.2
Fat	2.2	4.2	0. 0	1.1	9.7	5.5	0.3
Fiber	2.6	8.5	0.5	30.5	19	7.3	8.2
Ash	1.0	4.1	0.1	2.7	3.3	2.6	3.9
Wet Gluten	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbohydrate**	76.6	69.0	91.9	60	40.4	--	--

*Average of duplicate determination. ** Calculated by difference

Table 3: Mineral's content of raw materials (mg/100g)

	BRF	MLF	TS	LNF	LUF	TSG	AgAg
Ca	11	20	0	56	176	294	625
Fe	1.9	0.8	3.4	7.5	4.4	3.16	21.4
Zn	2.5	1.2	0	4.7	4.7	1.3	5.8
Na	8	9.8	79	6	15	45	102
K	288	92	0	955	1013	65	1125
Mg	111	84	0	122	198	128	770
Mn	3.96	1.8	0	1.3	2.4	2	0.4

Table 4: Chemical composition of gluten free flat bread prepared from different blends.

Groups			Protein %	Fat %	Fiber %	Ash %
	Wheat flour (Control – 1)		12.8	2.3	2.4	1.0
	GF commercial flour (Control – 2)		4.7	1.9	1.3	0.7
A BRF + TPS		20 / 80 %	1.79	0.46	1.05	0.29
		40 / 60 %	3.45	0.89	1.47	0.47
		60 / 40 %	5.11	1.33	1.89	0.65
		80 / 20 %	6.77	1.77	2.31	0.83
B MLF + TPS		20 / 80 %	2.31	0.86	2.23	0.91
		40 / 60 %	4.49	1.69	3.83	1.71
		60 / 40 %	6.67	2.53	5.43	2.51
		80 / 20 %	8.85	3.37	7.03	3.31
C BRF+TPS+ LNF	LNF	15 / 75 / 10 %	3.95	0.46	3.94	0.50
		35 / 55 / 10 %	5.59	0.89	4.36	0.68
		55 / 35 / 10 %	7.27	1.33	4.78	0.86
		75 / 15 / 10 %	8.93	1.77	5.20	1.04
D MLF+TPS+ LNF	LNF	15 / 75 / 10 %	4.34	0.76	4.83	0.97
		35 / 55 / 10 %	6.50	1.59	6.43	1.77
		55 / 35 / 10 %	8.70	2.43	8.03	2.57
		75 / 15 / 10 %	10.88	3.27	9.63	3.37
E BRF+TPS+ LUF	LUF	15 / 75 / 10 %	4.99	1.32	2.79	0.56
		35 / 55 / 10 %	6.63	1.75	3.21	0.74
		55 / 35 / 10 %	8.31	2.19	3.63	0.92
		75 / 15 / 10 %	9.97	2.63	4.05	1.10
F MLF+TPS+ LUF	LUF	15 / 75 / 10 %	5.38	1.62	3.68	1.03
		35 / 55 / 10 %	7.54	2.45	5.28	1.83
		55 / 35 / 10 %	9.74	3.29	6.88	2.63
		75 / 15 / 10 %	11.92	4.13	8.48	3.43

BRF = Brown rice flour –*MLF* = Millet flour –*TPS* = Tapioca starch *LNF* = Lentil flour -*LUF* = Lupine flour

Table 5: Mineral's content (mg) of gluten free flat bread Prepared from different blends.

Groups			Ca	Fe	Zn	Na	K	Mg	Mn
wheat flour Control - 1			120	4.9	2.9	122	405	118	4.1
Comercial GF Flour Control - 2			19	0.9	0.6	95	260	55	1.6
A BRF + TPS		20 / 80	2.2	3.1	0.5	65	58	24	0.8
		40 / 60	4.4	2.8	1	51	115	46	1.6
		60 / 40	6.6	2.5	1.5	36	173	68	2.4
		80 / 20	8.8	2.2	2	22	230	90	3.2
B MLF + TPS		20 / 80	5	2.9	0.2	67	19	17	0.4
		40 / 60	9	2.4	0.5	54	37	34	0.7
		60 / 40	13	1.9	0.7	40	56	50	1.1
		80 / 20	17	1.3	1	26	74	67	1.4
C BRF+TPS+ LNF	LNF	15 / 75 / 10	7	3.5	0.8	62	141	35	0.7
		35 / 55 / 10	9	3	1.3	47	198	52.4	1.6
		55 / 35 / 10	12	2.7	1.8	33	256	74.6	2.4
		75 / 15 / 10	14	2.4	2.3	19	313	96.8	3.2
D MLF+TPS+ LNF	LNF	15 / 75 / 10	9	3.4	0.7	64	110	25	0.5
		35 / 55 / 10	13	2.9	0.9	49	127	42	0.9
		55 / 35 / 10	17	2.4	1.1	35	144	58	1.2
		75 / 15 / 10	21	2.1	1.4	22	161	75	1.6
E BRF+TPS+ LUF	LUF	15 / 75 / 10	19	3.3	0.8	62	146	38	0.8
		35 / 55 / 10	22	3	1.3	48	204	60	1.6
		55 / 35 / 10	24	2.7	1.8	34	262	82	2.4
		75 / 15 / 10	26	2.4	2.4	20	319	104	3.2
F MLF+TPS+ LUF	LUF	15 / 75 / 10	21	3.1	0.7	63	116	34	0.4
		35 / 55 / 10	25	2.6	0.9	49	133	51	0.9
		55 / 35 / 10	29	2.1	1.1	35	149	67	1.2
		75 / 15 / 10	33	1.6	1.5	21	166	84	1.6

BRF = Brown rice flour – *MLF* = Millet flour – *TPS* = Tapioca starch - *LNF* = Lentil flour - *LUF* = Lupine flour

Table 6: Sensory evaluation of gluten free flat bread prepared from different blends.

		External Properties	Internal Properties	Total Acceptability
	Total score	30	70	100
Wheat flour (Control - 1)		28	67	95.0
Commercial GF Flour (Control - 2)		22	60	82.0
A BRF + TPS	20 / 80	27	64.5	91.5
	40 / 60	27	67	94.0
	60 / 40	27	68.5	95.5
	80 / 20	26	67	93.0
B MLF + TPS	20 / 80	26	65	91.0
	40 / 60	26	66	92.0
	60 / 40	27	66.5	93.5
	80 / 20	26	66.5	92.5
C BRF+TPS+ LNF	15 / 75 / 10	23	64	87.0
	35 / 55 / 10	23	65	88.0
	55 / 35 / 10	23	67	90.0
	75 / 15 / 10	22	66	88.0
D MLF+TPS+ LNF	15 / 75 / 10	21	62	83.0
	35 / 55 / 10	21	64	85.0
	55 / 35 / 10	21	66	87.0
	75 / 15 / 10	21	65	86.0
E BRF+TPS+ LUF	15 / 75 / 10	22	66	88.0
	35 / 55 / 10	22	67	89.0
	55 / 35 / 10	22.5	68	90.5
	75 / 15 / 10	22.5	66	88.5
F MLF+TPS+ LUF	15 / 75 / 10	22	64	86.0
	35 / 55 / 10	22.5	65	87.5
	55 / 35 / 10	22.5	66	88.5
	75 / 15 / 10	22	66	88.0

BRF = Brown rice flour -*MLF* = Millet flour -*TPS* = Tapioca starch -*LNF* = Lentil flour -*LUF* = Lupine flour

Table 7: Staling evaluation as alkaline water retention capacity *(AWRC)* % of gluten free flat bread prepared from different blends.

GROUPS		Zero time	24 hr.	48 hr.	72 hr.
Wheat flour Control - 1		366	351	339	330
Commercial GF Flour control - 2		367	340	326	311
A BRF + TPS	20 / 80	364	330	310	302
	40 / 60	364	338	320	312
	60 / 40	366	344	333	320
	80 / 20	366	352	337	326
B MLF + TPS	20 / 80	365	328	305	292
	40 / 60	364	330	310	300
	60 / 40	366	336	314	311
	80 / 20	365	341	322	318
C BRF+TPS+ LNF	15 / 75 / 10	368	349	335	320
	35 / 55 / 10	367	344	330	315
	55 / 35 / 10	366	339	321	307
	75 / 15 / 10	366	330	311	295
D MLF+TPS+ LNF	15 / 75 / 10	365	322	300	284
	35 / 55 / 10	364	324	305	291
	55 / 35 / 10	366	336	310	300
	75 / 15 / 10	365	339	314	307
E BRF+TPS+ LUF	15 / 75 / 10	364	347	337	325
	35 / 55 / 10	365	343	333	321
	55 / 35 / 10	364	340	330	318
	75 / 15 / 10	365	340	328	316
F MLF+TPS+ LUF	15 / 75 / 10	368	349	336	325
	35 / 55 / 10	366	342	330	318
	55 / 35 / 10	367	338	325	311
	75 / 15 / 10	366	331	320	306

BRF = Brown rice flour – *MLF* = Millet flour – *TPS* = Tapioca starch -*LNF* = Lentil flour - *LUF* = Lupine flour

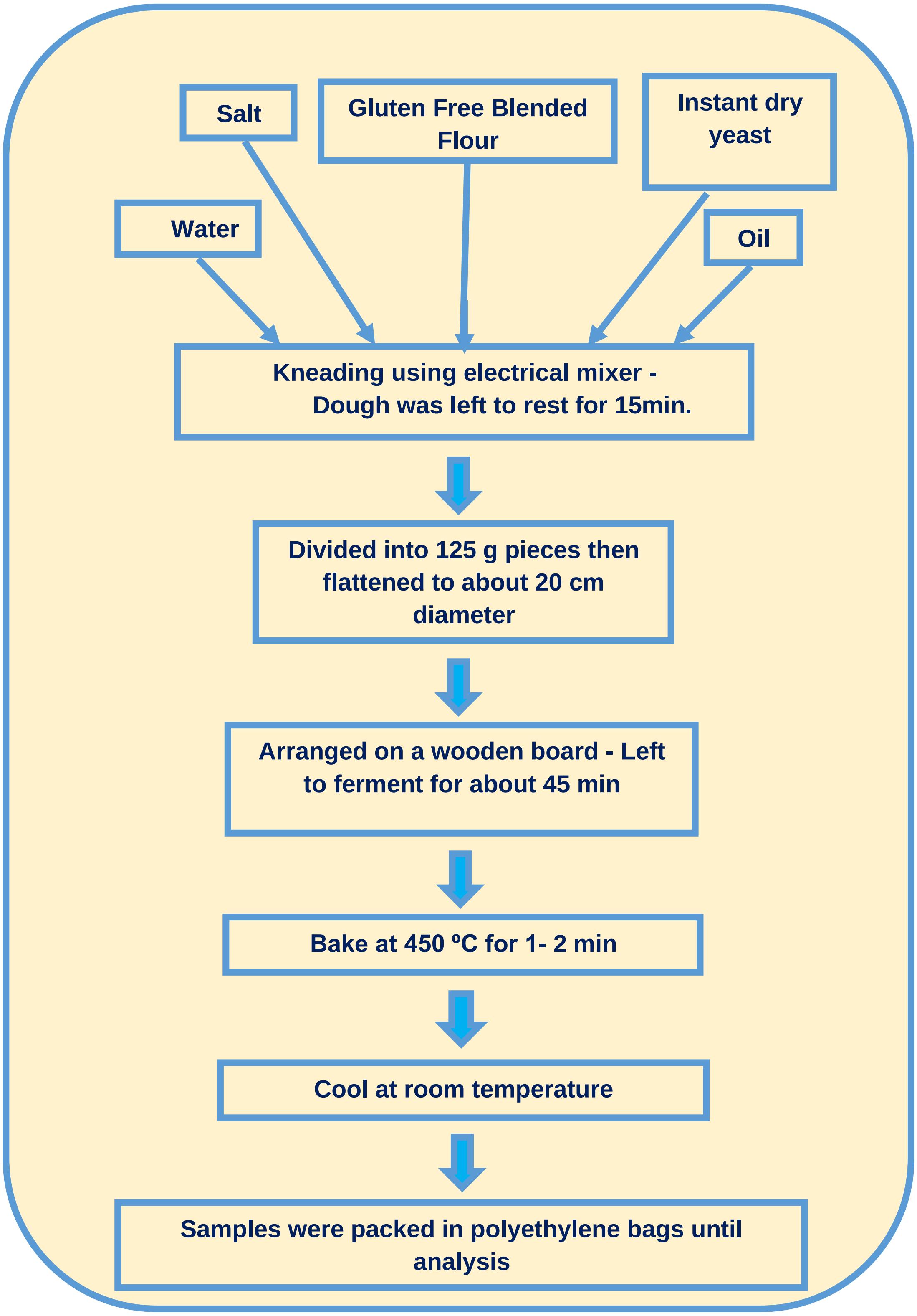

Figure 1: Flow chart for preparing of GF flat bread

التركيب الكيميائي والمحتويات المعدنية للخبز المسطح الخالي من الغلوتين المدعم بدقيق العدس ودقيق الترمس.

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الملخص العربي

تتكون معظم منتجات المخبوزات الخالية من الغلوتين من دقيق الذرة ودقيق الأرز ونشاء الذرة، مما يؤدي إلى نقص العناصر الغذائية (قيمة غذائية منخفضة)، لذلك تم إجراء البحث الحالي لدراسة تأثير الخلطات الخالية من الغلوتين المقواة والمكونة من البني. دقيق الأرز ودقيق الدخن ونشا التابيوكا بمستويات مختلفة مع دقيق العدس ودقيق الترمس. تم إجراء التركيب الكيميائي والمحتويات المعدنية والتقييم الحسي وتسخين الخبز أثناء التخزين في درجة حرارة الغرفة لمدة صفر و24 و48 و72 ساعة. أشارت النتائج إلى أن دقيق الترمس كان يحتوي على نسبة عالية من البروتين والدهون والكالسيوم والبوتاسيوم والمغنيغ مقارنة بدقيق العدس الذي يحتوي على نسبة عالية من الألياف والحديد. كان دقيق الدخن يحتوي على نسبة عالية من الرماد ودقيق الأرز البني كان عالياً في المنغنيز. يمكن الاستنتاج أن الترتيب التنازلي لتأثير التدعيم بدقيق الترمس ودقيق العدس كان على النحو التالي :الخبز المصنع من دقيق الدخن له قيمة غذائية أعلى من الخبز المصنوع من دقيق الأرز البني.,الخبز المصنع من دقيق الترمس المضاف لدقيق الدخن له قيمة غذائية أعلى من المصنع من إضافته لدقيق الأرز البني.,الخبز المصنع من دقيق العدس المضاف لدقيق الدخن له قيمة غذائية أعلى من الخبز المحضر من إضافته لدقيق الأرز البني. وكانت جميع أنواع الخبز المسطح الخالي من الغلوتين تحت هذه الدراسة أعلى درجة وأكثر قبولًا من عينات الخبز المسطح الخالي من الغلوتين المحضرة من الدقيق التجاري الخالي من الغلوتين (كونترول -2).

الكلمات الاسترشادية: الخبز، الغلوتين، دقيق العدس، دقيق الترمس.