Middle East Journal of Applied Sciences
Volume: 13 | Issue: 04| Oct. – Dec. | 2023

EISSN: 2706 -7947 ISSN: 2077- 4613
DOI: 10.36632/mejas/2023.13.4.42
Journal homepage: www.curresweb.com
Pages: 609-619

Preparation of Bakery Products as Preventive and Functional Foods Using Taro Flour

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Received: 04 Nov. 2023 **Accepted:** 05 Dec. 2023 **Published:** 10 Dec. 2023

ABSTRACT

For economic, health reasons and maximizing the use of taro which is underutilized food crops especially for youth in producing value added products. Moreover, it can be utilized these products for gluten sensitivity patient. In this study pan bread and flat free gluten bread were produced by blending varying proportions (5, 10, 15, and 20% levels) of taro flour with wheat flour and corn flour respectively. Before making taro flour in bread making. It was soaked in 0.5 % NaCO3 solution after boil at 100◦ C for 15 min. To remove oxalate then taro was dried and grinding to make taro flour. The produced breads were evaluated for chemical composition, physical and sensory properties. There were significant differences between protein, crude fiber, ether extract, ash and the total carbohydrates contents of all produced bread blends as well as the control sample. All prepared bread had acceptable score values of taste, texture, aroma and color. Minerals content increased by increasing taro flour concentrations. Texture profile parameters (hardness, adhesiveness and relicenses) decreased by increasing the percentage of composite taro flour in the blends. All bread samples of taro flour with wheat flour or corn flour recorded the allowance water activity level. Hence, high substitutions could considerably reduce the cost of raw materials and could nutritionally improve products with cereal blends.

Keywords: gluten sensitivity patients, pan bread, free gluten bread, taro flour.

1. Introduction

Taro (*Colocasia esculenta*) is a tropical and subtropical plant belongs Araceae family (Murugesan *et al.* 2020). The world production of taro is estimated at 11.8 million tons (Nath *et al.* 2012). The greatest global production comes from developing countries especially West Africa region such as Nigeria, Cameroon, Ghana and Ivory Coast. Egypt ranks the 8th place (FAO, 2008) with 151.97 tons/ year (Capms, 2019). The taro corm contained a significant amount of mucilage ranging between 1.33 to 8.05 gm/ 100 gm depending on the extraction method (Andrade *et al.,* 2020). It is heterogeneous polysaccharide formed from different sugars (such as arabinose, galactose, glucose, mannose, xylose) and uronic acid units.

The oxalates content has caused limited utilizations of taro (*Colocasia esculenta*) as a food material. The insoluble oxalates, especially needle like calcium oxalate crystal may cause irritation, and swelling of mouth and throat. Removal of oxalates in food can be done by physical processes, such as soaking, boiling, and cooking or chemical process by converting them into soluble phases. Soaking and boiling of taro corm chips in baking soda solution is still unable to reduce the calcium oxalate content to safe level (Kumoro *et al.*, 2014).

Mucilage extracted from Egyptian taro is considered a natural emulsifier with high emulsifying power. This is due to the presence of weak polar amino acids, especially leucine and isoleucine, which can bind both fat and water. It also has a high ability to absorb water to form a gel. In addition, it can

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be used in the production of baked good as a substitute for fat to reduce calories and the negative effect of lipids. This makes taro's mucilage better than artificial emulsifiers that have disadvantages such as high price, toxicity and some side effects (Basiony *et al.*, 2022).

Celiac disease occurs in 1% of the world population, induced by an environmental precipitate, gluten in genetically susceptible person (Grace-Farfaglia, 2015).

The gluten-free diet might sound simple but it is not easy, as it not only involves eliminating gluten-containing grains and all products that contain them, which requires constant vigilance, but there is also a sense of social isolation and pressure that accompanies the process.

Since most of the breads, biscuits, pasta, cakes, cookies, break-fast cereals, bagels, soups are made of wheat, avoidance of all these indicates a complete change in life style which might not be feasible for all. Due to all these reasons, the demand for gluten-free products is now on rise (Bauman and Friedlander, 2008). Since most of the breads, biscuits, pasta, cakes, cookies, break-fast cereals, bagels, soups are made of wheat, avoidance of all these indicates a complete change in life style which might not be feasible for all. Due to all these reasons, the demand for gluten-free products is now on rise, it could notice challenges faced by the developers are safety of the product, its acceptability and afford-ability and being in line with the guidelines approved by FDA (Food and Drug Administration) (Gallagher *et al.,* 2004).

Taro (*Colocasia esculent* Linn) is a vegetative propagated tropical root having its origin from South-east Asia. It occupies 9th position among world food crops with its cultivation spreader across Africa. Taro tubers are important sources for carbohydrates as an energy source and are used as staple foods in tropical and subtropical countries. 70–80% starch Taro is one of such crops grown for various purposes. It is an erect herbaceous perennial root crop widely cultivated in tropical and subtropical world belonging to genus (Colocasia) in the plant family called Araceae (Rashmi *et al.,* 2018). Moreover, it is also rich in calcium, phosphorus, iron, potassium and magnesium besides containing thiamine, riboflavin, niacin and Vitamin C. Generally, protein and fat content of taro is low but is high in carbohydrates, fiber and minerals. Albumin, at about 11% of total protein, is found in taro. Processing the taro tuber into flour or starch is the way of storage and expands its usage in some kind of formulation such as infant food. Also, taro tuber and roots are gluten-free (GF), which is important for celiac disease or other allergic reactions (Arıcı *et al.,* 2020)

Alternative wheat flour in bread making in Egypt is very important point to consider from an economic point of view that the price of wheat grain constantly fluctuates on international markets (Shaban *et al.,* 2020). Additionally, improving the free gluten bread is important for celiac diseases, besides encouraging the use of taro under- utilized food crops in producing value added products. So that, two types of bread (wheat pan bread and flat corn free gluten bread) were prepared by substituting wheat flour and corn flour individually by taro after drying and sieving as well as to determine the organoleptic acceptability of the resulting breads, proximate analysis, minerals content and shelf life quality.

This study aimed to utilize of taro Flow in some Functional bakery products. For this purpose, it can be replace different percentage of taro Flour instead of wheat flour or corn flour. Where as, it can replace 50 , 100 ,150 and 200 g of taro flour instead of corn Flour to be Suitable for gluten sensitivity patients. The study also aimed to replace 50, 100, 150 and 200 g of taro flour instead of wheat flour to reduce the economic cost of wheat products and increasethe he althy and nutritional value for products Consequently, itcould be reduced the cost of importing wheat flour.

2. Materials and methods

Materials

-Wheat flour 72 % was purchased from Al-Salam Company for Milling and Baking, Cairo, Egypt.
-Yellow corn flour 97 % was obtained from Egyptian Company for maize products 10th Ramadan City, Egypt.
-Taro corms, dry yeast, sugar, corn oil and salt were purchased from local market, Giza, Egypt.

Methods

Preparation of taro flour

Preparation of taro flour: Clean taro corms were hand-peeled and cut into slices 0.5 cm thick. The slices were soaked in 0.5% $NaCO_3$ Solution after boiling at 100 ˚C for 15 minutes to remove of calcium oxalate, then decant the water using muslin cloth as filter. The slice of taro was dried to a brittle texture in a convection oven (Type: VENTICELL55- Artikel Nr: 000721/10000 – Temp. Berech: 250°C – Anschlub:230V AC 50/60Hz – Leistungaufn. :1250W Germany) at 45 ± 3 ˚ C for 24 hr. Dried slices were fine-milled (500 µm) into flour using an electric grinder (Type: Moulinex MFP626 – 220V – 50-60Hz – 1000W – 250 ml France), passed through 250 µm sieve to obtain uniform sized flour, packaged in polyethylene bags and stored in a desiccator until using for further analysis (Hossain, 2016).

Preparation the blends for pan bread

Blends were prepared as shown in table 1, 2.

Table 1: The formula of pan bread (g)

Sample	Control p	P1	P2	P3	P4
Wheat flour	1000	950	900	850	800
Taro flour	-	50	100	150	200
Corn oil	30	10	10	10	10
Dry yeast	15	10	10	10	10
Salt	15	10	10	10	10
Sugar	60	60	60	60	60
Water	65	68	70	75	80

Table 2: The formula of tortilla bread (g)

Sample	Control T	T 1	T 2	T 3	T 4
Corn flour	1000	950	900	850	800
Taro flour	-	50	100	150	200
Corn oil	50	50	50	50	50
Dry yeast	10	10	10	10	10
Salt	10	10	10	10	10
Water	920	940	960	970	985

Preparing of pan bread

The straight dough method was used for production pan bread according to the method described by (Kent-Jones and Anos, 1967) with some modifications.

Preparing of free gluten bread

Gluten free bread was prepared as mentioned by Zahran, (2013) with some modifications.

Processing of free gluten bread

Gelatinization of corn flour: corn flour (one kg) was mixed with salt and dry yeast in boiling water and heated on hotplate for 15 min. with continuous mixing (Zahran, 2013).

The method

Corn flour 1 kg was mixed with 10 g dry yeast, 50 g corn oil and 10 g salt. Taro flour was incorporated in the dough as previous mentioned blends. Boiling tap water (920 ml) was heated for 15 min. with continuous mixing. The dough was left for 15 min. at 30Ċ and 85 % relative humidity then, the dough was divided into 25 g and flattens at thickness 3mm and fermented for 25 min. at 30°C with 85 % relative humidity, then baked at 350-400°C for 1-1.25 min. bread loaves were allowed to cool before scoring.

Chemical analysis for raw materials and two types of bread

- Crude protein, fat, ash and crude fiber were determined according to (A.O.A.C. 2011).
-Available carbohydrate was calculated by difference, 100-(protein + fat +fiber + ash) as mentioned by (Fraser and Holmes 1959).

-Total calories were calculated according to (FAO/WHO, 1991) as follows:

Calories kcal/100g = 4 x (carbohydrate % + protein %) + 9 x fat %.

-Determination of minerals: Minerals contents (Fe, Ca and Zn) were determined using methods of AOAC (2011). Perkin Elmer (Model 3300, USA) Atomic Absorption Spectrophotometer was used to determine these minerals.

Physical characteristics of pan bread and flat free gluten bread

Textural analysis of pan bread and free gluten bread: Texture analyzer (Brook field CT3 No. M08-372-C0113, USA) was used to measure the texture profile of produced pan bread and free gluten bread in terms of hardness (N), adhesiveness (mj), springiness (mm) and resilience of the samples according to the method described by (Gomez *et al.,* 2007)

Water activity (aw)

The water activity (aw) of free gluten bread was measured using Rotronic Hygrolab 3 CH-8303, Switzerland as measured by (Cadden, 1988).

Sensory evaluation of pan bread

After baking pan bread and cooling at room temperature, the following sensory evaluation was determined according to (Abd El-Latif ,1990) by ten experienced panellists from Food Technol. Res. Inst. Agriculture Research Centre. Appearance 20, crumb color 20, texture 20, odor 20, taste 20.

Sensory evaluation of free gluten bread

Sensory evaluation was determined and scoring scheme was established as mentioned by (Johnson and Harris, 1989).

General appearance 20, crust color 15, texture 10, taste 20, odor 10, roundness 10, layer separation 15, appearance and overall scores 100.

Statistical analysis

The obtained results for chemical composition three replicates for each sample, until ten replicates for sensory evaluation were analysed using analysis of one- way variance ANOVA Statistical significance was defined p ≤o.05. according to Ott (1988).

3. Results and discussion

3.1. Chemical composition of raw materials:

The chemical composition of wheat flour, yellow corn flour and taro flour is presented in Table 3. Taro flour has the highest content of available carbohydrates (85.94%), with non significant differences between wheat flour (p ≥0.05), also taro flour recorded the highest content in ash (4.1%), with significant differences among both wheat and corn flours. On the other hand, Wheat flour recorded the highest level of protein 11.03 %, while corn flour is the highest in fat 4.5%. Despite the different proportions of nutrients in raw materials, there was a convergence in the proportions of some nutrients these results are in symmetric with (Chinnasara and Maryasi, 2010) found that taro flour contained carbohydrates (86.48%), ash (3.13%), fat 0.1, fiber 2.3 %and 8.52 % protein. On the other hand, Arfa and Ali, (2022) reported that the yellow corn flour recorded fat and protein 4.77 and 8.68%, respectively.

Table 3: Chemical composition of raw materials (on dry weight basis).

Sample	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrates (%)	Calories kcal/100g
Wheat flour 72 %	$11.03^{a}\pm1.04$	$1.6^{b}\pm0.52$	$0.55^{b}\pm0.54$	$1.0^{b}\pm0.57$	$85.82^{a}\pm0.56$	$401^{a}\pm1.09$
Yellow corn flour 97 %	$6.23^{b}\pm0.23$	$4.5^{a}\pm0.51$	$1.82^{b}\pm0.50$	$3.12^{a}\pm1.03$	$84.33^{b}\pm1.03$	$402.74^{a}\pm0.32$
Taro flour	$6.01^{b}\pm0.57$	$0.75^{b}\pm0.32$	$4.1^{a}\pm0.30$	$3.2^{a}\pm1.00$	$85.94^{a}\pm0.53$	$374.55^{b}\pm0.56$
LSD at 0.05	1.05	0.82	1.13	1.39	1.13	1.06

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

3.2. Chemical composition of pan bread (on dry weight basis)

It is observed in Table 4, the effect of substitution of wheat flour by taro flour on the pan bread in terms of nutrients. Also, notice a high percentage of protein, fat, carbohydrate and calories in the control (10.5, 2, 85.08 and 406.62 %) respectively. As a result of substituting wheat flour by taro flour the protein, fat, carbohydrates and calories non-significant decreased in supplemented samples, these results agreed with (Silva *et al.,* 1999). Ash content of different blends ranged between 1.75 to 2.34%. It was observed that with an increase in the amount of taro flour, the ash content of the pan bread increased. This entails that incorporation of taro flour in the process of noodle making could enhance the mineral intake, as ash is indicative of the amount of minerals contained in any food sample (Olaoye *et al.,* 2007). The ash content was increased in supplemented pan bread this may be due to the high minerals content of taro flour comparing with the wheat flour. Although the protein, fat, ash, fiber and carbohydrate varied but, they are close to each other and did not different significant. Arfa and Ali. (2022) reported that the effect of substitution of yellow corn flour by taro flour on the crackers in terms of nutrients, they noticed that the percentage of ash and fiber increased meanwhile, protein decreased by increasing the substitution level from 20 % to 60 %. Although the chemical composition vary in their replacement rates, they are close to each other.

Table 4: Chemical composition of pan bread (on dry weight basis).

Sample	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrates (%)	Calories kg/100g
Control P	10.5^{a}±0.31	2^{a}±0.52	1.51^{ab}±0.5	0.91^{ab}±0.31	85.08^{a}±1	406.62^{a}±0.61
P 1	10.3^{a}±0.32	1.91^{a}±0.4	1.75^{ab}±0.3	1.06^{a}±0.21	84.98^{a}±0.22	400.42^{b}±0.43
P 2	10.0^{a}±1.0	1.82^{a}±0.4	1.93^{a}±0.2	1.21^{a}±0.22	85.04^{a}±0.22	397.69^{c}±0.42
P 3	9.8^{a}±0.51	1.73^{a}±0.2	2.13^{a}±0.2	1.36^{a}±0.31	84.98^{a}±1.01	394.77^{d}±0.12
P4	9.5^{ab}±0.21	1.55^{a}±0.2	2.34^{a}±0.3	1.51^{a}±0.51	85.1^{a}±0.52	391.79^{e}±0.31
LSD at 0.05	**0.87**	**0.66**	**0.51**	**0.51**	**1.89**	**0.95**

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control P: Control pan bread, P1: pan bread containing 5 % taro flour, P2: pan bread containing 10% taro flour, P3: pan bread containing 15 % taro flour, P4: pan bread containing 20% taro flour.

3.3. Minerals content of pan bread

Minerals content of all prepared breads was determined and listed in Table (5). Minerals are vital to the functioning of many body processes. They are critical players in the functioning of the nervous system, other cellular processes, water balance and structural (e.g. skeletal) systems (Ameh *et al.*, 2013). Inadequate intakes of micronutrients (minerals) have been associated with severe malnutrition, increased disease conditions and mental impairment (Shubhangini, 2002; and Abulude, 2005). It could be noticed that bread supplemented with taro flour had the highest content of Fe, Ca and Zn content compared with control bread and the values of the previous minerals increased gradually with increasing the addition of taro flour.

Table 5: Minerals content of pan bread mg/100g

Sample	Fe	Zn	Ca
Control P	2.11ab±0.11	0.84c±0.21	30.2e±0.22
P1	2.41b±0.22	1.21c±0.42	32.61d±0.23
P2	2.74b±0.32	2.22ab±0.23	34.81c±0.22
P3	3.24a±0.11	2.61a±0.51	36.89b±0.21
P4	3.52a±0.42	3.11a±0.42	38.61a±0.51
LSD at 0.05	**0.39**	**0.58**	**0.46**

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control P: Control pan bread, P1: pan bread containing 5 % taro flour, P2: pan bread containing 10% taro flour, P3: pan bread containing 15 % taro flour, P4: pan bread containing 20% taro flour.

3.3. Chemical composition of free gluten bread (tortilla) on dry weight basis

From the results in Table (6) it could be noticed that non-significant fluctuation in protein, fat and fiber among all samples. It could be noticed that ash and fiber slight increase in supplemented bread comparing with control. While significant decrease in calories in supplemented samples. Arfa and Ali. (2022) observed that with the increase in the substitution by taro flour with corn flour in crackers making the percentage of ash and fiber were increased meanwhile protein decreased by increasing the taro flour from 20 to 60 %.

Table 6: Chemical composition of free gluten bread tortilla on dry weight basis

Sample	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrates (%)	Calories kg/100g
Control T	5.81ᵃ±1.01	5.1ᵃ±0.51	1.71ᶜ±0.51	3.01ᵃ±0.52	84.37ᵃ±1.01	406.6ᵃ±0.61
T 1	5.61ᵃ±0.51	4.9ᵃ±0.72	2.81ᵃᵇ±0.52	3.21ᵃ±0.61	83.47ᵇ±0.52	400.42ᵇ±0.41
T 2	5.42ᵃ±0.42	4.69ᵃ±0.31	3.12a±0.51	3.32ᵃ±0.22	83.45ᵇ±0.41	397.69ᶜ±0.42
T 3	5.23ᵃ±0.23	4.49ᵃ±0.4	3.41ᵃ±0.42	3.51ᵃ±0.53	83.36ᵇ±0.32	394.77ᵈ±0.11
T 4	5.03ᵃ±1.0	4.31ᵃ±0.3	3.72ᵃ±0.52	3.72ᵃ±0.53	83.22ᵇ±0.21	391.79ᵉ±0.32
LSD at 0.05	**1.12**	**0.83**	**0.77**	**0.77**	**0.88**	**0.95**

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control T: Control tortilla bread, T1: tortilla bread containing 5 % taro flour, T2: tortilla bread containing 10% taro flour, T3: tortilla bread containing 15 % taro flour, T4: tortilla bread containing 20% taro flour.

3.4. Mineral contents of free gluten bread (tortilla).

The mineral contents of tortilla are shown in Table 7. Differences of raw materials affected on the mineral content in tortilla bread. The study showed an increase in the content of both Fe, Ca and Zn as a result of adding taro flour. It becomes clear that the content of mineral increased gradually by the level taro flour increased, it was noticed that the previous minerals in bread increased significantly compared with the control by adding taro flour. These results are consistent with Arfa and Ali (2022).

Table 7: Minerals content of corn flour bread (Tortilla) mg/100g

Sample	Fe	Zn	Ca
Control T	3ᵃᵇ±0.51	1.25ᶜ±0.31	29ᵈ±1.01
T1	3.4ᵃᵇ±0.42	1.51ᶜ±0.22	30.2ᵈ±0.51
T2	3.91ᵃ±0.43	2.03ᵃᵇ±0.21	32.51ᶜ±0.52
T3	4.32ᵃ±0.52	2.34ᵃ±0.32	35.32ᵇ±1.01
T4	4.62ᵃ±0.42	2.65ᵃ±0.23	38.21ᵃ±1.01
LSD at 0.05	**0.71**	**0.39**	**1.34**

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control T: Control tortilla bread, T1: tortilla bread containing 5 % taro flour, T2: tortilla bread containing 10% taro flour, T3: tortilla bread containing 15 % taro flour, T4: tortilla bread containing 20% taro flour.

3.5. Sensory evaluation of pan bread

Sensory evaluation is considered to be a valuable tool in solving problems involving food acceptability, product improvement quality maintenance and in a new product development. From the results presented in Table (8) taste, odor, appearance and texture values showed no significant differences compared with control bread until P3 bread. There is significant difference between different bread samples in crumb color compared with wheat control bread by increasing taro flour up 5 %. Moreover, overall acceptability in bread samples prepared with high percentage of taro were nearly close to those of the control bread. These results were in agreement with. (Kaushal and Sharma, 2014), who reported that control noodles were highly acceptable followed by noodles prepared from 50% taro flour substitution. Overall bread quality at the different levels of added taro flour was found to be acceptable. However, acceptability decreased as the level of taro increased, the bread become darker with taro flour addition. Meanwhile, it could be noticed that pan bread produced with taro flour until 20 %still have good acceptability.

Table 8: Sensory evaluation of pan bread

Sample	Appearance 20	crumb color 20	texture 20	Odor 20	Taste 20	Overall score 100
Control P	19ᵃ±1.01	19.5ᵃ±0.51	19.5ᵃ±0.51	19ᵃ±1.02	18ᵃᵇ±1	95ᵃ±0.52
P1	19ᵃ±0.52	18ᵃ±1.01	19ᵃ±0.52	19ᵃ±0.51	18.2ᵃᵇ±0.22	93.2ᵇ±0.21
P 2	19ᵃ±0.52	17.5ᶜ±1.02	18.16ᵃ±0.76	18.6ᵃ±0.42	18ᵃᵇ±1.04	91.26ᶜ±1.04
P 3	18.5ᵃ±1.01	17ᶜ±1.03	18.5ᵃ±1.02	18.5ᵃ±0.51	18.5ᵃ±0.55	91ᶜ±1.03
P 4	16ᵇ±1.01	16cᵈ±1.03	16ᵇ±1.03	18ᵃ±1.04	19.5ᵃ±0.54	85.5ᵈ±1.04
LSD 0.05	**1.34**	**1.5**	**1.26**	**1.17**	**1.14**	**1.29**

*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control P: Control pan bread, P1: pan bread containing 5 % taro flour, P2: pan bread containing 10% taro flour, P3: pan bread containing 15 % taro flour, P4: pan bread containing 20% taro flour.

3.6. Sensory evaluation of corn flour bread (Tortilla)

Sensory quality attributes of the bread expressed by experienced panelists are presented in Table (9). The addition of taro flour showed no significant differences for almost all sensory attributes until T3. Also, the results for general appearance, separation of layers and roundness were very close to those of control bread. In contrast taro flour supplementation improved the taste, this may be due to the dilution of bitter taste of corn flour as mentioned by panelists. Also, these results are similar to the one reported by Arfa and Ali, (2022). They reported that all samples of corn crackers supplemented with taro flour obtained a high score in the evaluation of the odor. As for the high overall palatability, the sample A 10 % taro flour (score8.3) and sample B 20% taro flour (score 8.1) were higher compared to the control sample corn flour (score 8.4). It is noted that the lowest score in sample C, but the differences between them and the rest of the samples are not great, so it is acceptable (Rahayu and Mulyatiningsih, 2018). So we found that taro flour can be utilized until 15 % in tortilla bread to improve the nutritional quality with good acceptability.

Table 9: Sensory evaluation of free gluten bread (tortilla)

Sample	General appearance 20	Crust color 15	Taste 20	Odor 10	Layer separation 15	Texture 10	Roundness 10	Overall score (100)
Control T1	19.9ᵃ±0.11	14.6ᵃ±11	19ᵃ±1	9.8ᵃ±0.29	12ᵃ±0.52	8ᵃ±1.07	12ᵃ±0.54	91.3ᵃ±1.09
T 1	19.9ᵃ±0.12	14.4ᵃ±0.13	19.5ᵃ±0.5	9.8ᵃ±0.11	12ᵃ±0.73	8ᵃ±0.51	12ᵃ±0.74	90.7ᵃ±0.74
T 2	19.6a±0.13	14.0 ᵃ±0.15	19.5ᵃ±0.2	9.8ᵃ±0.11	11.5ᵃ±0.54	8.5ᵃ±1.02	11.5ᵃ±0.54	90.8ᵃ±0.84
T 3	19.5a±0.51	14ᵃ±0.54	19.8ᵃ±1.0	9,6a±0.1	12ᵃ±1.04	8.6ᵃ±0.61	12ᵃ±1.09	90ᵃ±1.07
T 4	17b±0.52	13bb±13	19ᵃᵇ±0.5	9.5ᵃ±0.2	12ᵃ±0.54	8.8ᵃ±0.22	12ᵃ±0.51	84.2ᵇ±1.07
LSD 0.05	**0.52**	**1.08**	**0.89**	**0.34**	**1.07**	**1.17**	**1.07**	**1.45**

*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control T: Control tortilla bread, T1: tortilla bread containing 5 % taro flour, T2: tortilla bread containing 10% taro flour, T3: tortilla bread containing 15 % taro flour, T4: tortilla bread containing 20% taro flour.

3.7. The textural profile analysis (TPA) of pan bread

The main criterion for assessing the overall quality of pan bread is based on the evaluation of texture. The TPA results in table (10) showed a significant decrease in hardness in samples p1, p2, p3 and p4 compared with the control. Taro is considered a natural emulsifier with high emulsifying power thus the moisture retains with retarding the starch crystallization and decrease bread hardness (Basiony *et al.,* 2022). Adhesiveness is the adherence of the pan bread to the probe and the stage after the first compression

(Lu *et al.,* 2010). Adhesiveness was decreased by increasing the taro flour (Kaushal and Sharma 2014). The results showed that as the amount of taro flour increased in bread, Taro has a high ability to absorb water to form a gel. In addition, it can be used in the production of baked good as a substitute for fat to reduce calories and the negative effect of lipids. (Basiony *et al.,* 2022).

EISSN: 2706 -7947 ISSN: 2077- 4613 DOI: 10.36632/mejas/2023.13.4.42

Table 10: Textural profile analysis of pan bread

Sample	Hardness (N)	Adhesiveness mJ	Resilience
Control	2.74^{a}±0.52	2.32^{a}±1.05	0.95^{a}±0.11
P 1	2.71^{a}±0.53	2.01^{a}±0.51	0.08^{b}±0.01
P 2	2.5^{a}±0.41	1.83^{a}±0.33	0.06^{b}±0.01
P 3	1.92^{b}±0.52	1.55^{a}±0.52	0.05^{b}±0.02
P 4	1.5^{b}±0.33	1.34^{ab}±0.33	0.03^{b}±0.02
LSD 0.05	0.72	0.93	0.08

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control P: Control pan bread, P1: pan bread containing 5 % taro flour, P2: pan bread containing 10% taro flour, P3: pan bread containing 15 % taro flour, P4: pan bread containing 20% taro flour.

3.8. Instrumental Textural Parameters of gluten flat bread

Table (11) presents texture profile analysis results for gluten free bread, it could be observed that a decrease in hardness of bread supplemented with taro flour. The hardness was decreased gradually by increasing taro flour. Taro flour had a positive impact to decrease the hardness. Adhesiveness of tortilla was decreased as a hardness decreased. The similar relation between hardness, adhesiveness and resilience (Nassef and Hafez, 2020).

Table 11: Textural profile analysis of tortilla bread

Sample	Hardness (N)	Adhesiveness mJ	Resilience
Control	3.81^{a}±1.04	3.52^{a}±0.11	0.09^{a}±0.01
T 1	3.71^{a}±0.21	3.21^{a}±0.22	0.07^{a}±0.02
T 2	3.5a±0.52	3.01^{a}±0.53	0.05^{b}±0.02
T 3	2.92^{b}±0.52	2.98^{a}±1.06	0.03^{b}±0.02
T 4	2.5^{b}±0.53	2.71^{a}±0.22	0.02^{b}±0.01
LSD 0.05	0.96	0.83	0.03

*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level. Control T: Control tortilla bread, T1: tortilla bread containing 5 % taro flour, T2: tortilla bread containing 10% taro flour, T3: tortilla bread containing 15 % taro flour, T4: tortilla bread containing 20% taro flour.

3.9. Keeping quality of pan bread produced from wheat flour and different levels of taro flour

The measurement of water activity (a_W) has been shown useful for predicting the stability and safety of foods, with respect to microbial growth, deterioration reactions, and chemical and physical properties (Fontana, 1998., Cook and Johnson 2010) stated that aw is a particularly important factor influencing spoilage of many bakery products such as breads and cakes has levels above 0.94. When compared with the control, the pan bread and free gluten bread with taro flour substitution showed a significant difference in a_W. All formulations presented had good stability over the shelf-life, since they showed values of a_W equal or below 0.887 as reported by Cook and Johnson 2010. The results showed that P4 and T4made with 20% taro flour had higher moisture content. It is known that taro flour has fibers with high hygroscopicity which promotes high water retention (Wang *et al.,* 1997; Silva *et al.,* 1998).

Table 12: Moisture and water activity for produced pan bread and tortilla bread.

Samples	Moisture %	Water activity	Sample	Moisture %	Water activity
Control p	29.52^{e}±0.52	0.73^{a}±0.11	Control T	35.22^{e}±1.02	0.75^{a}±0.022
P 1	31.34^{d}±0.51	0.84^{a}±0.22	T1	37.2^{d}±2.06	0.85^{a}±0.23
P 2	33.23^{c}±0.31	0.85^{a}±0.33	T2	38.53^{c}±0.54	0.86^{a}±0.11
P 3	34.22^{b}±0.22	0.87^{a}±0.11	T3	41.3^{b}±1.06	0.88^{a}±0.22
P 4	35.31^{a}±1.01	0.88^{a}±0.22	T4	43.32^{a}±1.05	0.88^{a}±0.11
LSD 0.05	0.85	0.31	LSD 0.05	1.93	0.23

*Values are means of three replicates ±SD, Means in the same column followed by the same letter are not significantly different at 0.05 level. Control T: Control tortilla bread, T1: tortilla bread containing 5 % taro flour, T2: tortilla bread containing 10% taro flour, T3: tortilla bread containing 15 % taro flour, T4: tortilla bread containing 20% taro flour. Control P: Control pan bread, P1: pan bread containing 5 % taro flour, P2: pan bread containing 10% taro flour, P3: pan bread containing 15 % taro flour, P4: pan bread containing 20% taro flour.

4. Conclusion

Improving the nutritional quality of 2 types of bread without causing quality losses is a major challenge. Moreover, the variety of gluten-free bread needs to be increased in order to provide healthy diet for coeliac disease patients. This study aimed to explore alternative bread formulation by using taro flour. The results showed that taro flour is a contributing ingredient in terms of technological and nutritional properties of both wheat and gluten-free bread. The use of taro flour in bread can provide insights into alternative approaches to extend the bread types to the bakery industry. It can also be concluded that the use of taro flour up to 15 % as partial replacement of wheat flour in pan bread or corn flour in tortilla bread can be considered for the production of bread with perceptible taste, good acceptability, higher nutritional value and also good texture and shelf life quality. It can also be recommended to use tortilla bread for gluten sensitivity patients because it is gluten free. Finally, it could be stated that, taro flour has an increasing interest as it is important ingredient in the food industry such as functional and healthy foods formulations as pan bread and tortilla bread.

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