Rheological and Sensory Effect of Flaxseed and Chickpea Flour Mix on Products Wheat-Based

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Abstract:

Current study aimed to prepare toast bread and cookies from wheat flour (WF) replaced with different levels of flour of mixed flaxseed (FF) and chickpea (CHF) at 20 and 30%. The chemical composition of Mix30 recorded the highest content of protein (13.9%), fat (7.88%), ash (1.32%) and fiber (0.92%) in comparison to WF100. The results clarified that the moisture content of composite flours decreased with the increase in ratio of other flours; WF100 had the highest moisture content (10.65%) and Mix30 had the lowest content (9.35%). WF100 had a high carbohydrate content (76.33%) and Mix30 had the lowest content (66.66%). Mix 30 had the highest antioxidant activity (AA), total flavonoids (TFC), total phenols (TPC) and antioxidant capacity. In rheological properties, the results of farinograph parameters during the mixing stage showed an increase in the water absorption, arrival time and behavior of dough development in Mix20 and Mix30, while showing a decrease in stability time compared to WF. Extensograph analysis of WF and mixed FF-CHF at different levels (20 and 30%) showed the highest increase in elasticity, and proportional number was found in the mix at 30%. Toast bread and cookies with a of mix 20% showed a higher texture, taste, odor and preferred sensory score as compared to a mix of 30%. According to the sensory analysis results,it can be concluded that mixed flaxseed (FF) and chickpea (CHF) can be used in toast and cookies up to 20 and 30% levels.

Key words: Functional food, toast bread, cookies, composite flour.

1. Introduction

Wheat bread is a cheap staple diet but it contains a low amount of lysine and other important amino acids so it has a significant nutritional drawback. Legumes have emerged as an affordable and environmentally sustainable protein source with the ability to increase the nutritional value of breads **(Srivastava and Chakraborty, 2018).** Also, most cookies are manufactured with refined wheat flour, which is weak in some key amino acids and other nutrients; they can be fortified with a variety of protein- and fiber-rich items to increase their nutritional value **(Kaur *et al*., 2019).**

Flaxseeds (*Linum usitatissimum L.)* are a plentiful source of nutritional and bioactive substances. Antioxidants, which include vitamins, minerals and phytochemicals, may be partially responsible for the health advantages. One of the crucial phytochemicals found in foods made from plants is phenol **(Wang *et al*., 2017).** Flaxseed has a number of bioactive substances, and those that are abundant (protein, oil, mucilage and lignans) have undergone thorough characterization and research. As a result, numerous products are now offered in a variety of forms on the market **(Campos-Vega *et al.*, 2020).**

Legumes have a high concentration of bioactive chemicals such as fibers and essential amino acids and may supplement some nutritional and functional qualities and inadequacies of a cereal-based diet. Adding legume flour to wheat bread merits special consideration **(Rizzello *et al*., 2014).** Chickpeas are regarded as a wholesome, nutrient-dense food that has a high protein level and is rich in fiber, vitamins, minerals and vital amino acids **(Milán-Carrillo *et al*., 2007; Jukanti *et al*., 2012 and Capurso *et al*., 2018).** Chickpea flour has no effect on the texture of food products made with it and has improved health benefits. The amount of carbohydrates and fat in food products can be greatly reduced by a slight addition of this flour, while increasing the amount of protein, fiber and mineral elements;

Chickpeas and their protein may reduce the amount of acrylamide that forms in baked goods made with wheat flour **(Rachwa-Rosiak et *al*., 2015).**

So, the current study was conducted to evaluate the effect of fortifying the wheat toast bread and cookies a mixture of FF and CHF at different levels on rheological and sensory properties.

2. Materials and methods

2.1. Materials

Flaxseeds, chickpeas, wheat flour (72%), yeast, eggs, sugar, butter, vanilla, baking soda, milk, and chocolate- which the main ingredients used in this study were obtained from a local market in Minia Governorate, Egypt. The wheat flour was stored immediately in the refrigerator until it was used in the preparation of the products.

2.1.1. Reagents and chemicals

All solvents and chemicals were obtained from El-Gomhoryia Company for chemicals, medical instruments and trading drugs in Cairo, Egypt.

2.2. Methods

2.2.1. Preparation flaxseed and chickpea flours

According to **Marpalle *et al*., (2014)** flaxseed was roasted in a skillet at 80 to 90 °C for ten minutes and then flaxseed flour was made using a laboratory grinder (Toshiba Elaraby, Egypt) and sieved as shown in photo (1).

Chickpea flours were processed according to **Costa *et al.* (2020)** by submerging them in water (3 parts water to 1 part grain) for 12 hours,

Photo (1): Flaxseeds flour

Photo (2): Chickpea flour

drying them at 180 °C for 1 hour in an electric oven, then pulverizing and sieving them through a mesh size of 10 to become the fine flour shown in photo (2). All flour samples were filled and kept in glass jars at 4°C until they were analysed and products prepared**.**

2.2.2. Preparation Composite Flours: -

Flaxseed flour and chickpea flour at levels of 20 and 30% have been blended with wheat flour as shown in Table (1). The flour blends were then maintained in the refrigerator in an airtight container for further process analysis and product preparation after being individually packaged in sealed polyethylene bags.

Table (1): Composite flours of WF, FF and CHF:

Abbreviation of Sample	Mixture (dry weight)
WF 100	Wheat flour 100%
MIX 20	80% Wheat flour + 10%Flaxseeds flour + 10%Chickpea flour
MIX 30	70% Wheat flour + 15%Flaxseeds flour + 15%Chickpea flour

2.2.3. Preparation of toast bread:

According to **Nassef *et al.*, (2023)** make toast bread with a few adjustments, as stated in Table (2). Combine the ingredients (butter, sugar, salt and yeast) with the flour; add the water and milk gradually and then knead the dough for 5 to 10 minutes, or until it is soft and smooth. The dough should be covered and placed in a sizable bowl with plastic wrap. Let it rise for about 55 minutes or until puffy. Mold is used to contain the dough. 30 minutes were spent resting the dough, followed by 30 minutes of baking at 180°C, air cooling, and storage in polyethylene bags for sensory characteristics.

Table (2): Formula of toast bread

Samples / Ingredients	WF 100%	MIX 20%	MIX 30%
WF	440 g	352 g	308 g
FF	___	44 g	66 g
CHF	___	44 g	66 g
Butter	42 g	42 g	42 g
Salt	6 g	6 g	6 g
sugar	22 g	22 g	22 g
Moist Yeast	7 g	7 g	7 g
Water(ml)	174	174	174
Milk (ml)	125	125	125

2.2.4. Preparation of cookies

Cookies were made according to **Mohibbullah *et al.*, (2023)** method with a few adjustments, as stated in Table (3). To prepare the dough, the butter was combined with the powdered sugar, followed by the eggs, vanilla, flour, salt, and baking soda. The dough was then formed using gloves and chocolate chips, baked for 20 minutes at 170°C, allowed to cool naturally and then placed in polyethylene bags for use in sensory testing.

Table (3): The Formula of cookies

Samples / Ingredients	WF 100%	MIX 20%	MIX 30%
WF	200 g	160 g	140 g
FF	___	20 g	30 g
CHF	___	20 g	30 g
Butter	100 g	100 g	100 g
Salt	0.5 g	0.5 g	0.5 g
Backing soda	5 g	5 g	5 g
Vanilla	3 g	3 g	3 g
Powder Sugar	160 g	160 g	160 g
Chocolate chips	100 g	100 g	100 g
Egg	1	1	1

2.2.5. Chemical properties

Fiber, ash, moisture, protein and fat contents were determined according to **A.O.A.C, (2012)**; carbohydrate content was calculated as follows:

Carbohydrate (%) = 100 – (fat % + moisture% + fiber % + ash % +protein %).

2.2.6. Determination of total flavonoids (TFC), total phenols content (TPC), antioxidant activity (AA %) and total antioxidant capacity (TAC) :-

Abu Bakar *et al.*, (2009) used the colorimetric method to determine the total flavonoids for WF, CHF and FF. Total phenol content was determined according to **Musa *et al.*, (2011)** by using the Folin-Ciocalteu reagent. Antioxidant activity was calculated by **Oms-Oliu *et al*., (2009).**

The 2, 2- diphenyl -1 picrylhydrazyl (DPPH) radical scavenging ability was performed, the antioxidant ability was calculated using the following equation:

$$\mathbf{AA\% = \frac{Abs_{DPPH} - Abs_{sample} \times 100}{Abs_{DPPH}}}$$

Where:

AA: antioxidant ability.

Abs $_{\mathbf{DPPH}}$: absorbance of DPPH -free radical solution in methanol.

Abs $_{\mathbf{sample}}$: absorbance of DPPH -free radical solution mixed with sample extract.

The determination of total antioxidant activity was done as per the phospho-molybdenum method with some modifications **Kanika *et al*., (2015).**

2.2.7. Determination of rheological dough

According to **A.A.C.C. (1969)** methods were tested for farinograph and extensograph for WF and composite flours with a mix of FF and CHF at different levels of mix (20 and 30%). The following equation was used to calculate absorption values:

Absorption % = (x + y - 300) /3

Wherever:

X: ml of water needed to generate the curve with maximum matchmaking entered on 500 BU. Line.

y: flour grams equal to 300 g of 14 percent moisture foundation.

The extensograph test effects were determined as extensibility, resistance to extension and energy (region under curve, cm_2).

2.2.8. Evaluation of sensory properties of toast bread and cookies

30 panellists, comprising faculty, postgraduates and students from the Faculty of Specific Education at Minia University in Egypt, participated in the sensory evaluation. Each participant received three randomly coded samples of each product on a round glass plate. The products (toast and cookies) were created with composite wheat flour and a mix of flaxseed and chickpea flour mix (20 and 30%). A10-point scale was used to evaluate the odor, taste, texture, overall acceptability and color of the samples. To rinse the samples in between, water was provided.

2.2.9. Ethical Approval

Experiments, especially the sensory evaluations for this study, were approved by the Ethics Committee of Scientific Research, Faculty of Specific Education, Minia University.

2.2.10. Statistical Analysis

Using the General Linear Model software as a statistical analysis method we analyzed data **(SAS, 2003)** and used double range tests to compare the average **(Duncan, 1955)**.

3. Result and Discussion

3.1. Chemical analyses

3.1.1. Chemical analyses and nutritional value of wheat flour mixed with flaxseeds andchichpea flour mixture at levels (20 and 30%):-

The proximate analysis of composite flours (wheat, flaxseed and chickpea mixture) was shown in Table (4). The effect of incorporation different ratios flours on the chemical properties of composite flours are discussed as follows:-

-Moisture content:-

The moisture content of composite flours was analysed and ranged from 9.35 to 10.65 %, depending upon the blending proportions; i.e. WF100 (10.65%), Mix20 (9.78%) and Mix30 (9.35%). The results clarified that the moisture content of composite flours decreased with an increase in the ratio of other flours. Our results were in agreemen with **Chandra *et al.*, (2015)** who confirmed that the moisture content of composite flours decreased with a decrease in the proportions of wheat flour. As well as, **Kaushal *et al.*, (2012)** who explained that using blends of pigeon pea, taro and rice flour reduced the moisture content of composite flours.

-Fat content:-

The fat content of different flour samples ranged from 1.56 to 7.88%. From Table (4), it is clear that the maximum value of fat content was observed in Mix30 (7.88%) whereas the lowest value was observed in WF100 (1.56%). The fat content of composite flours increased with an increase in the level of incorporation ratio FF. Our results agree with **Kaur *et al.*, (2017)** who reported that the composite flours from wheat-flaxseed flour showed high fat contents.

-Protein content:-

In developing countries, legumes alone contribute to about 33 % of the dietary protein nitrogen needs of humans and legume proteins are rich in lysine. Thus,many research efforts have been mad to enrich cereal flour with legume flour sources **(Rochfort and Panozz, 2007).** The data in Table (4) shows that the protein content of composite flours was WF100 (10.56%), Mix20 (12.85%) and Mix30 (13.9%). These results confirm that when adding FF and CHF at different concentrations to WF lead to an increase in the protein content of the composite flour. Our results agree with **Hefnawy *et al.*, (2012)** who reported that composite flours made from wheat-chick pea flour showed high protein content.

<u>Table (4):</u> Proximate chemical content of WF mixed with FF and CHF mixture at level (20 and 30%):-

Chemical Composition g.100g^{-1}	WF 100%	Mix 20%	Mix 30%
Moisture	10.65±0.09[a]	9.78±0.03[b]	9.35±0.03[c]
Protein	10.75±0.55[b]	12.85 ±0.48[a]	13.9±0.46[a]
Fat	1.56±0.034[c]	5.77±0.25[b]	7.88±0.20[a]
Fiber	0.15±0.04[c]	0.66±0.08[b]	0.92±0.10[a]
Ash	0.59±0.02[c]	1.07±0.01[b]	1.32±0.01[a]
Carbohydrates	76.33±0.28[a]	69.88±0.24[b]	66.66±0.21[c]

✳Each value reflects the mean value of three ± SD replicates.
✳Mean values of various letters in the same raw average at p≤0.05 stage is substantially different.

-Ash and Fiber content:-

The data in Table (4) showed that the ash content of composite flours was WF100 (0.59%), Mix20 (1.07%) and Mix30 (1.32%). In contrast, when comparing the content of fiber in WF with all parameters; results show an increase in fiber content of (0.15, 0.66 and 0.92%) respectively, for WF100, Mix20 and Mix30 respectively. Our data were in agreement with results obtained by **Kaur *et al.*, (2017)** who confirmed that composite flours made from wheat-flaxseed flour showed high fiber and ash contents.

-Carbohydrate content:-

The carbohydrate content of composite flours was analysed and ranged from 66.66 to 76.33%, depending upon the blending ratios; i.e. WF100 (76.33%), Mix20 (69.88%) and Mix30 (66.66%).The results clarified that the carbohydrate content of composite flours decreased with an increase in the ratio of other flours.

3.2. Phytochemicals Composition

3.2.1. Total phenols, flavonoids, antioxidant activity and antioxidant capacity of WF mixed with FF and CHF mixtures at levels (20 and 30%):-

The content of phenols, flavonoids, antioxidant activity and antioxidant capacity were measured in WF, which was replaced by FF and CHF mixtures at different levels (20, 30%) as shown in Table (5).

-Total phenol content:-

The results in Table (5) show that the total phenols content of composite flours increased with an increase in the ratio of other flours; total phenols content ranged from (95.63 to 138.9 mg GAE/100g) depending upon the blending proportions; i.e. WF100 (95.63 mg GAE/100g), Mix20 (124.5 mg GAE/100g) and Mix30(138.9 mg GAE/100g). Our results agree with **Pourabedin *et al.*, (2017)** who found that an increase in phenolic compounds in bread samples was observed with the increased amount of flaxseed flour substituted for wheat.

-Total flavonoids content:-

The total flavonoids content of different flour samples ranged between (92.9, 104.17 and 109.8 mg quercetin /100g). From Table (5), it is clear that the maximum value of total flavonoids content was observed in Mix30 (109.8mg quercetin /100g), whereas the lowest value was observed in WF100 (92.9 mg quercetin /100g).

Total flavonoids content of composite flours increased with an increase in the incorporation ratios of FF and CHF. **Cameron and Hosseinian, (2013)** confirmed that flaxseed has health benefits because flaxseed is considered an excellent source of antioxidants such as phenolics.

Table (5): Total phenols, flavonoids, antioxidant activity and antioxidant capacity of WF mixed with FF and CHF mixture at level (20 and 30%):-

samples → / ↓ Parameters	WF 100%	Mix 20%	Mix 30%
Total phenols (TPC)	95.63±0.20 [c]	124.5±0.29 [b]	138.9±0.51 [a]
Total Flavonoids (TFC)	92.9±2.70 [b]	104.17±5.13 [a]	109.8±6.45 [a]
Antioxidant activity (AA%)	51.87±1.59[c]	57.79±1.34[b]	60.75±1.22[a]
Total Antioxidant capacity (TAC)	67.15±0.85 [c]	91.51±1.32 [b]	103.7±1.58 [a]

✳Each value reflects the mean value of three ± SD replicates.
✳Mean values of various letters in the same raw average at p≤0.05 stage is substantially different

- Antioxidant Activity (AA%) and Total Antioxidant Capacity (TAC) :-

In the same Table (5), antioxidant activity (AA) value for all samples ranged from (51.87- 60.75%). Mix30 recorded the highest score of AA was (60.75%), followed by the Mix20 was (57.79%), while WF100 recorded the lowest value (51.87 %) respectively. As well, the total antioxidant capacity (TAC) value ranged from (67.15-103.7). Mix 30% recorded the highest score of TAC (103.7), while WF recorded the lowest value (67.15). This ability is due to the high content of these samples of phenolic compounds such as phenols and flavonoids; because phytochemicals present antioxidant activity by donating hydrogen and producing stable intermediate radicals **(Samtiya *et al*., 2020).**

3.3. Dough Properties

3.3.1. Farinograph Parameters of WF mixed with FF and CHF mixture at level (20 and 30%):-

The effect of the addition of FF and CHF on the rheological behavior of WF measured by Brabender is presented in Table (6) and figure (1). During the mixing stage, all cases observed an increase in the water absorption, arrival time, and behavior of dough development. The highest increase in water absorption was found in Mix 30% which was 62.5. This is due to the increased content of protein and fiber in flaxseed flour compared to wheat flour.

Our results agreed with **Xu *et al.*, (2014) and Mostafa *et al.*, (2019)** who confirmed that the mixture of wheat flour and flaxseed flour leads to an increase in dough absorption for water compared to the control sample. Also, the current results show a slight increase in water absorption in the formula Mix30 compared with wheat flour; this increase may be due to the higher water-holding capacity of chickpea flour (**Sulieman *et al.*, 2013). Shahzadi *et al.*, (2005)** found that protein content enhanced the water holding capacity which may be due to increase in pentosans, especially ribose and deoxyribose.

The data in Table (6), shows that the highest dough development time observed in Mix 30% was (4.6 min). **Pourabedin *et al.*, (2017)** showed that dough development time significantly ($p<0.05$) increased in the samples containing flaxseed flour compared to the control sample. **Koca and Anil**, **(2007)** reported the longer development time as a possible result of gluten dilution, difficult flaxseed fiber and the wheat flour mixing process. The phenomenon could also be attributed

to the presence of gum in flaxseed.

Table (6): Farinograph parameters of composite dough WF, FF and CHF:-

Parameters → / Samples↓	Water absorption (%)	Arrival time (min)	Dough development (min)	Stability time (min)	Degree of softening
WF 100%	58.0 c	1.5c	2.5 c	4.5 a	50c
MIX 20%	61.0 b	2.7b	5.2 b	3.5 b	62b
MIX 30%	62.5 a	4.6a	6.0 a	3.0 c	90 a

∗Mean values of various letters in the same raw average at p≤0.05 stage is substantially different

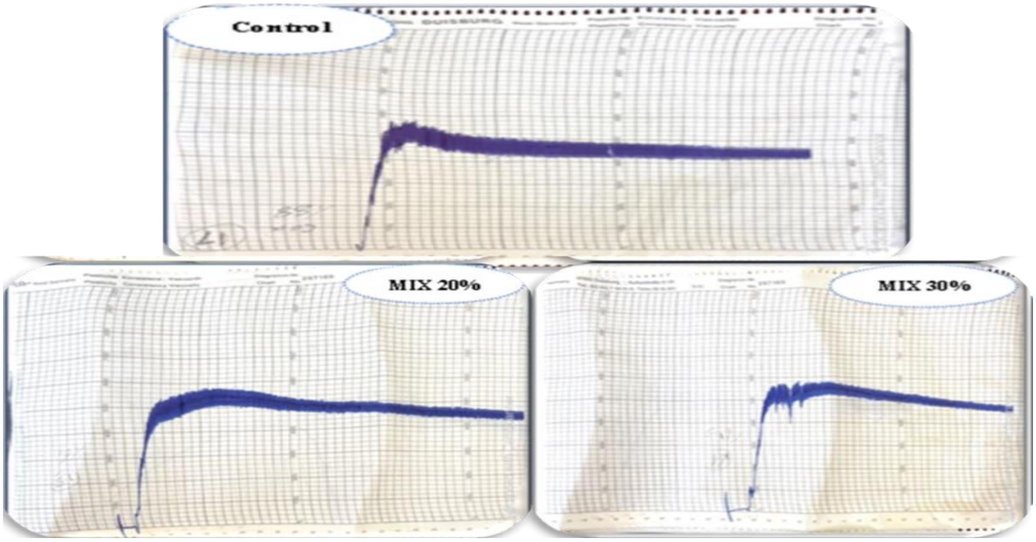

Figure (1): Farinograph parameters of WF mixed with mixture FF and CHF at 20 and 30%

The dough stability time decreased markedly from 4.5 min for WF 100 to 3.0 min for Mix 30 .The observed weakening of the dough could be due to the combined lower gluten content of the flour **(Barak *et al.*, 2013)**. The addition of legume flour to wheat flour has been shown to enlarge the protein network and linearly dilute the covalently linked gluten network by the weakly linked legume proteins, thus making the wheat dough weaker **(Laleg *et al*., 2017)**. Moreover, the addition of FF and CHF to WF showed an increased in the degree of softening. WF100, Mix 20 and Mix 30 had (50, 62 and 90) respectively.

3.3.2. Extensograph Parameters of WF mixed with FF and CHF mixture at levels (20 and 30%):-

Table (7) shows the results of the extensograph analysis of WF with mixed FF and CHF at different levels (20 and 30%).The energy value is an essential parameter in terms of the dough's resistance to processing; the gas holding capacity and fermentation tolerance of the dough are raised when this value is higher . The results of the extensograph parameters presented in Table (7) showed a significant difference (P<0.05) in the elasticity value of samples. The highest value found in Mix 30 was (455 B.U), followed by Mix 20 (440 B.U), and WF 100% samples had the lowest elasticity value (430 B.U). Also, Table (7) shows that the resistance to extension of dough showed a significant reduction,and the extensibility of control dough (WF) remained higher than Mix 20 and Mix 30. This is because wheat flour and gluten were diluted by the incorporation of CHF and FF, and the induced strength reduction of dough became highly evident with the increase of CHF and FF. **Liu *et al*., (2018)** reported that flaxseeds flour contains more lipids, proteins and fiber, these components can affect the formation of a gluten network by interacting with gluten and starch.

Our data were consistent with those of **Delvarianzadeh *et al*., (2020)** who confirmed that the extensibility of the dough were decreased by addition of flaxseed meal. This finding could be due to the increasing level of fiber in the dough which makes the dough harder in the presence of flaxseed meal.

Table (7): Extensograph parameters of WF mixed with FF and CHF mixture at levels (20 and 30%):-

Samples	Elasticity (B.U)	Extensbility (min)	Proportional number (P.N)	Energy (cm_2)
WF 100%	430^{c}	155^{a}	3.30^{b}	65^{a}
MIX 20%	440^{b}	125^{b}	2.51^{c}	50^{b}
MIX 30%	455^{a}	105^{c}	4.16^{a}	46^{c}

✳Mean values of various letters in the same raw average at p≤0.05 stage is substantially different

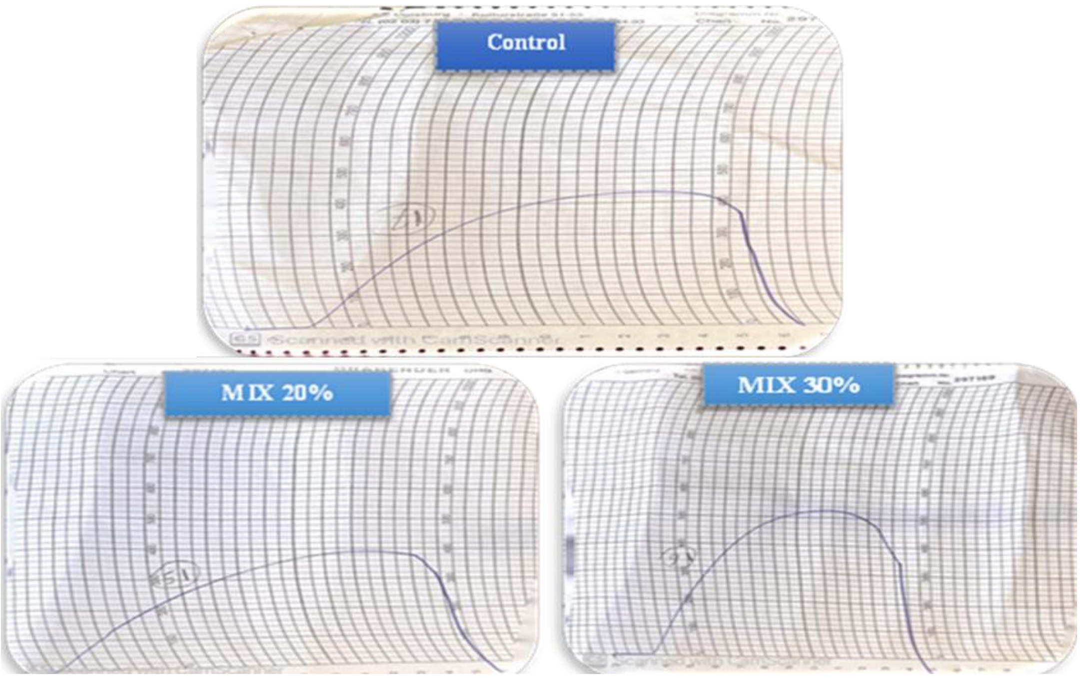

Figure (2): Extensograph parameters of WF mixed with mixture FF and CHF at 20 and 30%

3.4. Sensory Propreties

3.4.1. Sensory evaluation of toast bread prepared by WF mixed with FF and CHF mixture at levels (20 and 30%):-

The sensory evaluation of any food item is a fundamental step in the development of food products since it determines whether the product will be accepted or not. The influence of adding mixed FF and CHF (20 and 30%) to WF was significant in terms of the sensory characteristics, including color, odor, taste, texture and overall acceptability of the toast bread were summarized in Table (8). A significant decrease ($P<0.05$) in all properties was observed in the presence of additional amounts of mixed flaxseeds and chickpea flour. Moreover, the increased level of addition of mixed flaxseeds and chickpea flour to wheat flour decreased in odor, taste and overall acceptability compare to control sample. The color of toast bread product with WF had the highest score value (9.5) compared to all samples, followed by the toast bread product with Mix 20, while toast bread with Mix 30% had a lower score value.

The texture of the toast bread product with WF had the highest score value (9.55) compared to all samples, followed by the toast bread product with Mix 20. As well, the toast bread product with a 30% mix was the least valuable (8.32) in texture Table (8), photo (3) this could be due to the the level of substitution of flours incorporation used that is affected on texture of the product. For odor, data present in Table (8) showed that the control toast bread has the highest score value (9.6), while sample product with mix 30% has the least score value (8.4). Also, the result shown taste score value for toast bread are decreased in all samples compare to control sample (9.45) and Mix 30 had the lowest taste score value (8.22).

The results were presented in Table (8) for the overall acceptability of toast bread samples ranged from 8.5 to 9.47. The control sample followed by the sample product with Mix 20 had the highest value in overall acceptability (9.47, and 9.25) respectively. Among the incorporated samples,the toast supplement with Mix30 had the lowest overall acceptability (8.5). Although, the sensory scores of toast followed a decreasing trend with the increased addition of mix, however was reasonably good. Our results were agreed with **Hefnawy *et al*., (2012)** who reported that the sensory results indicated that control bread had the highest overall acceptability scores followed by bread from mixture and addition 30% chickpea flour to the wheat composite flours lead to improved rheological properties, this improvement was translated into good bread making potential.

Table (8): Sensory evaluation of toast bread prepared by WF mixed with FF and CHF mixture at level (20 and 30%):-

Sensory properties	WF 100% (Control)	Mix	
		20%	30%
Color	**9.5±0.67[a]**	**9.35±0.85[a]**	**8.62±0.76[b]**
Texture	**9.55±0.50[a]**	**9.25±0.77[a]**	**8.32±1.14[b]**
Odor	**9.6±0.58[a]**	**9.28±0.99[a]**	**8.4±1.02[b]**
Taste	**9.45±0.50[a]**	**9.15±0.79[a]**	**8.22±0.90[b]**
Overall acceptability	**9.47±0.58[a]**	**9.25±0.62[a]**	**8.5±0.87[b]**

*Each value reflects the mean value of three ± SD replicates.
*Mean values of various letters in the same raw average at $p \leq 0.05$ stage are substantially different.

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Photo (3): Toast bread prepared by WF mixed with FFand CHF mixture at level (20 and 30%)

As well as, **Marpalle *et al*., (2014)** confirmed that the sensory properties muffin containing milled flaxseed by weight was rated as significantly less acceptable than the control muffin. On other hand**, Mostafa *et al*., (2019)** reported that no significant differences between the toast sample made from wheat flour with 5% flaxseed flour and the control sample in the in all the sensory properties evaluated; while, significant differences between the samples with 10% and 15% flaxseed flour substitution and the control sample.

Sulieman *et al*., (2013) found that bread made with chickpea flour was found to be more acceptable in sensory evaluation and improved the nutritional value of bread produced. Our results agreed with **Mohammed *et al*., (2012)** reported that substitution of chickpea flour at 10, 20 or 30% lead to reduced bread making potential degree of reduction depends on the substituent level.

However, substitution at >20% chickpea flour gives parameter values at least as good as the control sample, while the blend with <20% shows a substantial decrease in all values measured.

3.4.2. Sensory evaluation of cookies prepared by WF mixed with FF and CHF mixture at levels (20 and 30%):-

Color, texture, odor, taste and overall acceptability of cookies prepared by WF mixed with FF and CHF mixture at level 20 and 30% were presented in Table (9) and photo (4). Color was no significant difference ($P \leq 0.05$) between samplesWF and Mix 20 while the lowest value was observed in sample Mix 30%. Texture of Mix20 was the highest score value (9.7) compare to all samples, followed by cookies product from WF. The odor ranged from 9.5 to 9.78. The result showed taste and overall acceptability was the highest value in WF compare with Mix 20 and Mix 30 samples.

Results were agreed with **Hamid and Shimy, (2013)** who found that samples contain chickpea flour have the highest overall acceptability. Taste color and flavor score of biscuits supplemented with chickpea are increasing ratio. And our results were agreed with data obtained by **Rajiv *et al.*, (2012)** who showed that the sensory characteristics of cookies showed were adversely affected beyond 15% level of FF. The cookies with FF had brownish colour, hard texture, dominating foreign flavor and had the lowest total score, which increased hardness in texture of cookies lead ti increase the level substitution of FF. **Kaur *et al.*, *(*2017)** explained that the sensory panellists rated of control sample with highest score for color and flavour. These were closely followed by blend containing FF 15%. Highest overall acceptability scores were for 15% of flaxseed cookies and the level of overall acceptability scores of substitution was decrease in acceptability scores with increase the level of replacment.

Our data in the same line with **Khouryieh and Aramouni, (2012)** confirmed that flaxseed flour can be incorporated in cookies as a partial replacement up to 12% of wheat flour without negatively affecting the physical and sensory quality.And with **Man *et al.*, (2021)** showed that the sensory attributes of the samples with FF were decreased compared to the control, the aroma and crispiness increased and the significant differences between samples in appearance, hardness, chewiness and aftertaste did not reflect on the overall appreciation of the biscuits. Also, **Hussain *et al.*, (2006)** studied the effect of addition flaxseed flour in wheat flour for prepared cookies.

Table (9): Sensory evaluation of cookies prepared by WF mixed with FF and CHF mixture at level (20 and 30%):-

Sensory properties	WF 100% (Control)	Mix	
		20%	30%
Color	**9.7±0.46[a]**	**9.7±0.46[a]**	**9.1±0.62[b]**
Texture	**9.6±0.58**	**9.7±0.46**	**9.45±0.59**
Odor	**9.78±0.41**	**9.7±0.46**	**9.5±0.5**
Taste	**9.9±0.3[a]**	**9.7±0.46[b]**	**9.4±0.49[b]**
Overall acceptability	**9.9±0.3 [a]**	**9.7±0.46 [ab]**	**9.5±0.5 [b]**

*Each value reflects the mean value of three ± SD replicates.
*Mean values of various letters in the same raw average at $p \leq 0.05$ stage are substantially different.

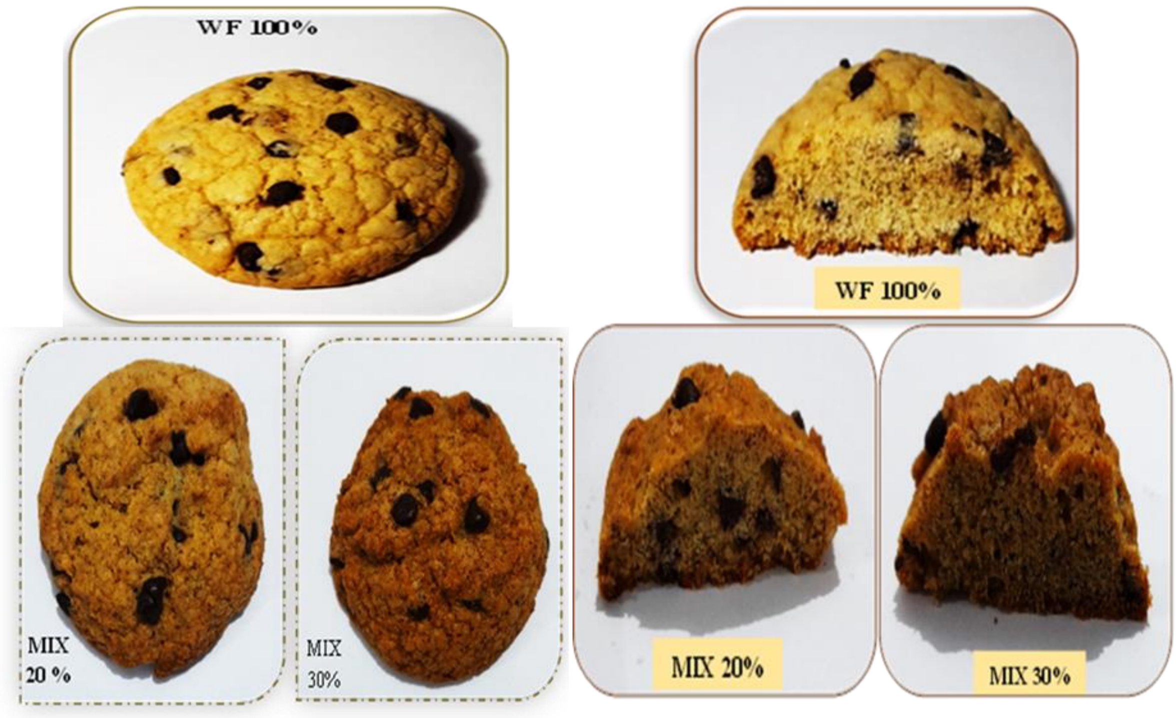

Photo (4): Cookies prepared by WF mixed with FFand CHF mixture at level (20 and 30%)

Conclusion

By considering all properties of the toast bread and cookies samples, this study has concluded that mixing wheat flour with flours of mixed (flaxseed and chickpea) led to changes in the rheological and sensory properties of all products. Although, the sensory scores of toast bread and cookies followed a decreasing trend with the increased addition of mix, the consumer survey showed good acceptance of products by the majority of them.

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التأثير الريولوجي والحسي لخليط دقيق بذور الكتان والحمص في منتجات بدقيق القمح

المستخلص:-

هدفت الدراسة الحالية إلى تحضير خبز التوست والكوكيز من دقيق القمح واستبداله بمستويات مختلفة من خليط دقيق بذور الكتان والحمص بنسبة 20 و30%. سجل التركيب الكيميائي للخليط 30% أعلى محتوى من البروتين (13.9%)، الدهون (7.88%)، الرماد (1.32%) والألياف (0.92%) مقارنة بدقيق القمح. كما أوضحت النتائج أن المحتوى الرطوبي للدقيق المركب يتناقص مع زيادة نسبة الدقيق المضاف؛ إحتوى دقيق القمح على أعلى محتوى رطوبة (10.65%) وكربوهيدرات (76.33%) بينا أحتوى دقيق الخليط 30%على أقل محتوى رطوبة (9.35%) وكربوهيدرات (66.66%). أظهر خليط 30% أعلى نشاط مضاد للأكسدة ، وإجمالي الفلافونويد والفينولات والقدرة المضادة للأكسدة. في الخواص الريولوجية، أظهرت نتائج معاملات الفارينوجراف خلال مرحلة الخلط زيادة في امتصاص الماء ووقت الوصول، وسلوك تطور العجينة في عينات خليط 20 و30% ، بينما اظهرت نقص في زمن الثبات للخلطات مقارنة بدقيق القمح. وبتحليل الاكستنسوجراف لعينات دقيق القمح وخليط بنسبة 20 و30٪، أظهرت عينة الخليط 30% أعلى زيادة في المرونة والعدد النسبي. أظهر خبز التوست والكوكيز في نسبة الخلط 20% قوامًا وطعمًا ورائحة ودرجة قبول أفضل مقارنةً بنسبة الخلط 30%. وفقا لنتائج التحاليل الحسية يمكن استنتاج أنه يمكن استخدام دقيق خليط بذور الكتان والحمص في خبز التوست و الكوكيز بمستويات تصل إلى 20 و30٪.

الكلمات المفتاحية: الأغذية الوظيفية، خبز التوست، الكوكيز، الدقيق المركب.