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BENEFITING FROM FLAX SEEDS AND MILLET IN PRODUCTION OF BREAD FOR CANCER PATIENTS

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Phenolic compounds found in a wide variety of plant foods, which had preventative or reduction role in development and spread of cancers. Thus, the consumption of high levels of plant-derived foods rich in phenolic compounds lead to lower the incidence rates of various cancers. Flaxseed is one of the foods that has large amount of lignans. Millet is an excellent source of bioactive substances and polyphenols, which can scavenge free radicals. This study seeks to determine the effect of substitution of wheat flour with flaxseeds (FF) and millet (MF) flours on the bread quality. Wheat flour was substituted with [10/30 (T_1), 20/20 (T_2) and 30/10 (T_3)] FF/MF. Chemical composition, total phenolic content, rheological properties, alkaline water retention capacity (AWRC), staling rate and sensory evaluation were evaluated. The results showed that as the FF proportion increased and MF decreased, the protein, ash, fat, fiber, calorie value and phenolic content were improved. The lowest AWRC and staling rate was recorded with T3 sample followed by T_1 sample, where the highest value was logged with T_2 sample. Higher stability time, resistance to extension and extensibility were found with T_1 sample followed by T_2 and T3 samples. The overall acceptability value of the prepared flat bread samples was the same for both T_1 and T_2 samples followed by T_3 samples with scores close to each other. The incorporation of flaxseeds and millet flours improved the total phenolic content of the prepared bread with good rheological and sensory properties.

Keywords: anticancer food, bread, lignans, rheological properties, total phenol

INTRODUCTION

There was a great interest in diets that prevent cancer, many types of cancer are causing due to factors relating to lifestyle and nutrition habits. Diets provide a variety of polyphenols which are useful for cancer patients. The health benefits of polyphenols have been linked mostly to their antioxidant effects where it has been reported to reduce inflammation and cancer recurrence by acting as an antioxidant, increasing antioxidant gene and decreasing cancer cell proliferation. Numerous phenolic compounds have the capacity to scavenge free radicals and aids in the prevention and sample of diseases brought on by free radicals (Braakhuis et al., 2016; Nithiyanantham et al., 2019 and Durga et al., 2021). Phenolic compounds had a significant role in enhancing the human immune system to identify and destroy cancer cells as well as preventing the development of new blood vessels that is necessary for tumor growth. Therefore, the consumption of diets rich in polyphenols for a long-term could protect against certain cancers (Chandrasekara and Shahidi, 2010 and Fujiki et al., 2015).

Flaxseed (*Linum usitatissimum)*, from Linaceae family is one of the oldest crops in the world (Singh et al., 2011), growing in many countries, especially those ringing the Mediterranean Sea. Flaxseed is the richest source of ω-3 fatty acid (α-linolenic acid) and the lignans (Salim et al., 2011), which are polyphenols that can work as phytoestrogens and antioxidants (Tour and Xueming, 2010 and Tannous et al., 2020). It is also an essential source of dietary fiber (28 g/100 g), high-quality protein (20 g/100 g), fat (41 g/100 g), total carbohydrate (29 g/100 g) (Zuk, et al., 2011 and Katare et al., 2012), phenolic compounds, particularly secoisolariciresinol diglucoside (SDG), ferulic acid, p-coumaric acid, and water-soluble carbohydrates (Waszkowiak and Barthet, 2015). During the intake of flaxseeds, SDG is ingested, then metabolized and transformed into two lignans types, enterodiol (END) and enterolactone (ENL), by the gut microbiota (Pan et al., 2007), these lignans are potential therapeutic in many diseases such as arteriosclerosis, diabetes mellitus and have an anti-proliferative effect on human breast cancer cells, melanoma, lung cancer, and leukemia cancer (Giada, 2010; Mali et al., 2012; Chikara et al., 2017 and Tannous et al., 2020).

Millet (*Pennisetum glaucum* L.) is one of the grains that belong to Poaceae family (Durga et al., 2021). Millet grains are a great source of polyphenols and bioactive compounds which act as antioxidants, where guard against oxidative stress and cytotoxic effects. Also, useful in the management of many physiological disorders such as hypertension, diabetes mellitus, hypercholesterolemia. In addition, these compounds have anti-inflammatory, anticarcinogenic, antimicrobial, antidiarrheal, antiulcer, and anti-cardiovascular properties (Singh et al., 2015 and Durga et al., 2021). The significant category of phenolic chemicals found in all varieties of millet grains includes gallic acid, tannins, gentisic acid, protocatechuic acid, caffeic acid, vanillic acid, syringic acid, ferulic acid, para coumaric acid, trans cinnamic acid and 5 n-alkyl-resorcinols (Nithiyanantham et al., 2019 and Durga et al., 2021). Millet grains are very easy to digest due to their high content of lecithin, which is crucial for the wellbeing of the nervous system.

(Selladurai et al., 2023). Millet grains are considered a good source of protein (8-11.6 g/100 g), fat (2.4-5 g/100 g), crud fiber (1.2-2.2 g/100 g), carbohydrate (57-69 g/100 g) and minerals (2.3 mg/100 g). Also, millet grains are rich in iron, zinc, phosphorous, magnesium, vitamin A, thiamine, riboflavin, niacin and folic acid (Nambiar et al., 2011). Regular consumption of millets containing high amounts of phenolic compounds and dietary fiber supposed to have a higher anti-carcinogenic activity and lowers the risk of developing cancer (Chandrasekara and Shahidi, 2011), thus millet could be used as a functional food in the prevention and therapy of cancer diseases.

Therefore, the objective of this study was to evaluate the effect of using flaxseed and millet flours as substitution on the chemical, total phenolic content, rheological, alkaline water retention capacity (AWRC), staling rate and sensory characteristics of the bread processed as an attempt to benefit from flaxseed and millet flours in the production of bread for cancer patients.

MATERIALS AND METHODS

1. Materials

Wheat flour (WF), 72% extraction, flaxseed grains, yeast, and salt were obtained from local market, millet grains (*Pennisetum glaucum*) were obtained from New Valley governorate, Cairo, Egypt. Guar gum was obtained from Alpha Zyme Company, El-Asher of Ramadan, Sharkiya governorate, Egypt.

2. Preparation of Flaxseed (FF) and Millet (MF) Flours

Flaxseed and millet grains were cleaned from dust and foreign materials and were ground to flour in an electric grinder stainless steel (made in france; LM240 6A06 495 (b)) and sifted through a 60 mesh and finally were packed and stored at –18ºC until used.

3. Preparation of Flat Bread Samples

The flat bread was prepared according to Moselhe (2001), where the bread ingredients were mixed and kneaded, then dough rested 30 min. The dough was divided into individual loaf-sized pieces which are made round to become a gas retention capability and good flattening (Boyacýoglu, 1999). The dough was sheeted 2 to 10 mm thickness. Then, the dough rested for 30 min and baked on a hot plate for 15-30 seconds (Talay, 1997). WF was substituted with FF and millet flour MF as formulations described in Table (1).

4. Analytical Methods

4.1. Chemical analysis

Fat (ether extract) and crud fiber of WF, flaxseed flour (FF) and millet flour (MF) of raw materials and flat bread samples were estimated according to A.O.A.C. (2007). Also, moisture, protein, and ash were determined using

Inframatic 8600 NIR Analyzer with 6-7 narrow band interference filters (6-7 wave lengths). Total carbohydrates were calculated by difference.

Table (1). Formulation of wheat, flaxseed and millet flat bread samples.

Ingredients (%)	Flat bread samples		
	T_1	T_2	T_3
WF	60	60	60
FF	10	20	30
MF	30	20	10
Yeast	2.0	2.0	2.0
Salt	0.5	0.25	0.25
Guar gum	1.0	1.0	1.0
Water	According to water absorption		

4.2. Calorie value

Calorie values were calculated for WF, FF, MF and flat bread samples according to El-Hadidy (2020) using the following equation:

Calorie value (kcal/100 g) = (% carbohydrate × 4) + (% protein × 4) + (% fat ×9).

4.3. Bioactive total phenolic content

Bioactive total phenolic content was determined for the WF, FF, MF and flat bread samples according to Renata et al. (2012), where one gram of WF, FF, MF and flat bread samples were homogenized with 20 mL of 80% ethanol. The mixture was kept in the dark at room temperature overnight, filtered (0.45 μm) and stored at -18°C until determination. One milliliter of alcoholic extract was added to 1 mL 95% ethanol, 5 mL distilled water and 0.5 mL 1 N Folin-Ciocalteu reagent. After 5 min, 1 mL 5% Na_2CO_3 was added, and the reagent mixture was kept for 60 min at room temperature. The quantification of phenolic compounds was performed spectrophotometrically by measuring the absorbance in UV-VIS spectrophotometer Shimadzu 1240, at 725 nm, and a gallic acid (10-100 μg/mL) in 95% ethanol was used for obtaining a standard curve.

4.4. Alkaline water retention capacity of flat bread samples

The Alkaline water retention capacity (AWRC) was determined as described by Kitterman and Rubanthaler (1971), as following: After baking, the bread was cooled at room temperature, and then stored at 24°C in sealed polyethylene bags to prevent moisture loss. At zero, 2 and 4 days of storage at room temperature, bread was cut into small pieces, dried at 50°C under reduced vacuum oven and then ground on a stein mill to pass through a 60-mesh stainless steel sieve. Five grams of dried flat bread sample was placed into a 50 ml dry plastic centrifuge tube. Then, 25 ml of $NaHCO_3$ solution (8.4 sodium bicarbonate dissolved in one-liter distilled water) were added. The tube was stopped and shake until all packed products became wet. Then, the mixture was left for 20 min with shaking every 5 min the contents were then centrifuged at 2500 rpm for 15 min. After centrifugation, the supernatant was decanted, and the precipitate was left for 10 min at 45˚ angle to get rid of free water. The percentage of the absorbed alkaline solution to 5 g of baked products were calculated as follows:

AWRC % = [(Weight of tube with sample after centrifuge – weight of empty tube) / Weight of sample] x 100.

4.5. Staling rate of flat bread samples

Staling rate (SR) of different flat bread samples were determined after 2 and 4 days of storage period at room temperature according to Abd El-Khalek et al. (2019) using the following equation:

SR % = [(AWRC0 – AWRCn)/ AWRC0] x 100

Where: AWRC0: AWRC at zero time.

AWRCn: AWRC at a specific day of storage.

4.6. Rheological properties of composite flour samples

Rheological properties of different composite flour samples (T_1, T_2 and T_3) were evaluated using farinograph and extensograph measurements according to A.A.C.C. (2000).

4.7. Sensory evaluation of flat bread samples

The sensory evaluation of prepared flat bread samples was evaluated according to Lucia et al. (2011). Ten panelists in the desert research center were requested to evaluate the most acceptable samples for sensory attributes of flat bread samples (color, odor, taste, crust color, texture and over all acceptability). Moreover, a ten-point hedonic rating scale, where 1 corresponded to extremely unpleasant, 10 to extremely pleasant and 5 to acceptable, was used to quantify each attribute.

5. Statistical Analysis

The collected data were analyzed using the SPSS (Statistical Program for Sociology Scientists) Statistics Version 20 for computing the mean values, LSD, ANOVA ($p < 0.05$) and Duncan Multiple Range test (Armonk, 2011).

RESULTS AND DISCUSSION

1. Chemical Composition of Wheat, Flaxseed and Millet Flours

Data in Table (2) show the proximate chemical composition of WF, FF and MF on dry weight basis. Moisture content of MF (10.7%±0.08) was significantly higher than both WF (7.3%±0.13) and FF (7.28%±0.1). Also, data illustrated in Table (2) clarify that crude protein, total ash, ether extract and crude fibers contents of FF recorded the highest significant values (19.2%±0.64, 9.49%±0.01, 35.19%±0.18 and 8.03%±0.03, respectively) followed by MF (12.73%±0.14, 9.21%±0.03, 2.28%±0.03 and 0.81%±0.01, respectively), where WF recorded the lowest values (10.42%±0.13, 0.55%±0.01, 2.19%±0.01 and 0.00%±0.0, respectively). On the contrary, the significantly highest total carbohydrates value was found to be with WF

(79.55%±0.25) followed by MF (64.26%±0.14) then FF (20.89%±1.6). Regarding energy value, it was noticed that FF recorded a highest calorie value followed by WF then MF. Abd El-Nabey et al. (2013) informed that the calorie content of flaxseed flour is high due to its high content of oil.

El-Tanahy et al. (2021) illustrated that moisture content of pearl millet was 11.21%, crude protein was 11.07%, total ash was 1.48%, ether extract was 5.88% and crud fiber was 1.39%, for millet flour. Abd El-Nabey et al. (2013) observed a higher crude protein (22.04%) and ether extract (39.18%) contents and lower moisture content (5.82%), total ash (5.66%) and crude fibers (5.5%) for flaxseed flour. Moisture content, total ash, ether extract and crude fibers observed values for FF was found to be higher than those obtained by Elshehy et al. (2018), who notified that the values of moisture content, total ash, ether extract and crude fiber of flaxseed flour was 5.3, 3.13, 21.9 and 1.13%, respectively. The crude fiber content of FF was in accordance with value mentioned by Hussain et al. (2008), who mentioned that the crude fiber of flaxseed flour was 8.02%. Regarding chemical composition of WF, El-Said et al. (2021) and Sharoba et al. (2009) observed a higher crude protein value and lower ether extract value, but the total ash value was nearly in agreement. The result of WF crude protein value was higher than those reported by Abd El-Hady and Abd El-Galeel (2012), who reminded that the crude protein value was 10.2%.

Table (2). Chemical composition of wheat, flaxseed and millet flours (g/100 g dry wt. basis).

Chemical composition (%)	**Raw materials**		
	WF	**FF**	**MF**
Moisture content	07.30±0.13[b]	07.28±0.10[b]	10.70±0.08[a]
Crude protein	10.42±0.13[c]	19.20±0.64[a]	12.73±0.14[b]
Total ash	00.55±0.01[b]	09.49±0.01[a]	09.21±0.03[a]
Ether extract	02.19±0.01[b]	35.19±0.18[a]	02.28±0.03[b]
Crude fiber	00.00±0.00[c]	08.03±0.03[a]	00.81±0.01[b]
Total Carbohydrates	79.54±0.25[a]	20.81±1.60[c]	64.26±0.14[b]
Calorie (Kcal)	379.55±0.15[b]	476.75±0.12[a]	328.48±0.10[c]

WF: wheat flour, FF: flaxseeds flour and MF: millet flour. Mean value ± Standard deviation of three replicates, means sharing the same letter in the same raw are not significantly different at $p< 0.05$.

Also, the presented data in Table (2) show that the calorie value was 476.75 kcal/100 g, 379.55 kcal/100 g and 328.48 kcal/100 g for FF, WF and MF, respectively. These results are lower than those observed by Mansour et al. (2021), who found that the calorie value of both wheat flour and whole millet flour was 402.57 kcal/100 g and 416 kcal/100 g, and with Kaur et al. (2019), who reported that the calorie value of flaxseed flour was 530.02

kcal/100 g. Mansour et al. (2021) mentioned that, the increment in calorie value may be due to the higher content of fat or total carbohydrates.

2. Chemical Composition of Flat Bread Samples

The chemical composition of flat bread samples are demonstrated in Table (3). A highly significant moisture content was observed with T_1 sample (8.94%) followed by T_2 (8.79%) and T_3 (8.45%) samples. These results are in accordance with those observed by Zidan (2021), who illustrated that the moisture content of toast bread fortified with millet flour are increased as the millet flour proportion increased. Singh et al. (2012) and Kulkarni et al. (2021), indicated that increasing in moisture content by increasing millet flour may be due to the high moisture retention capacity of millet flour. Khouryieh and Aramouni (2012) mentioned that moisture content decreases when the amount of flaxseed flour increased from 0 to 12%.

Table (3). Chemical composition of flat bread samples (g/100 g dry wt. basis).

Chemical composition (%)	Flat bread samples		
	T_1	T_2	T_3
Moisture content	$8.94{\pm}0.10^{a}$	$8.79{\pm}0.13^{b}$	$8.45{\pm}0.12^{c}$
Crude protein	$14.90{\pm}0.09^{c}$	$15.68{\pm}0.08^{b}$	$17.87{\pm}0.05^{a}$
Total ash	$6.93{\pm}0.01^{c}$	$7.12{\pm}0.02^{b}$	$8.05{\pm}0.02^{a}$
Ether extract	$21.50{\pm}0.43^{c}$	$22.86{\pm}0.03^{b}$	$23.51{\pm}0.06^{a}$
Crude fiber	$0.15{\pm}0.01^{b}$	$0.66{\pm}0.01^{a}$	$0.66{\pm}0.01^{a}$
Total carbohydrates	$47.58{\pm}0.50^{a}$	$44.89{\pm}0.15^{b}$	$41.82{\pm}0.16^{c}$
Calorie (Kcal)	$443.42{\pm}0.13^{c}$	$448.02{\pm}0.12^{b}$	$450.35{\pm}0.12^{a}$

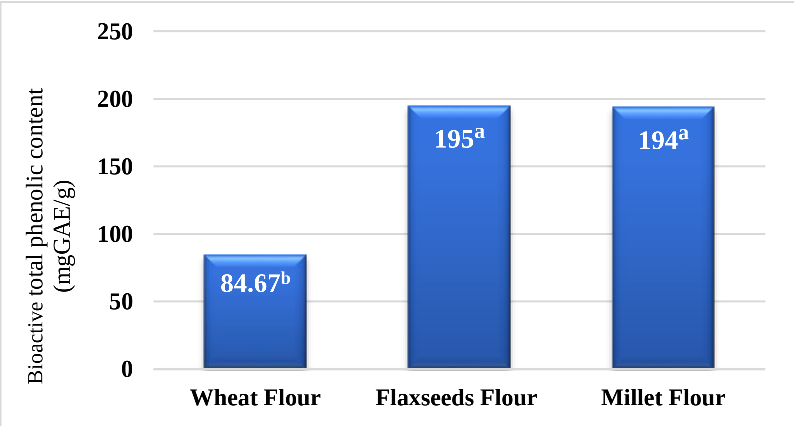
T_1: 10% flaxseed flour+30% millet flour, T_2: 20% flaxseed flour+20% millet flour, T_3: 30% flaxseed flour+10% millet flour. Mean value ± Standard deviation of three replicates, means sharing the same letter in the same raw are not significantly different at $p< 0.05$.

Moreover, results in Table (3) show that crude protein, total ash, ether extract and crude fiber were significantly increased with T_3 sample followed by T_2 and T_1 samples. On the contrary, the total carbohydrates decreased. These may be due to the increment in FF proportion compared to MF proportion in the flour formula of the prepared bread. Zidan (2021) demonstrated that the crude protein, fat and carbohydrates values decrease as the millet flour proportion increases. Also, Devani et al. (2016) observed a significant decrement in total carbohydrate, crude protein and fat as the millet flour proportion increases in the white bread formulation. Khorshid et al. (2011) found that the chemical composition of both pane and balady bread increase expect total carbohydrate as the flaxseed flour increases. El-Demery et al. (2015) clarified that the supplementation of wheat flour by 10% of flaxseeds flour enhances the crude protein, total ash, crude fiber and fat content of toast bread. Mounika and Sireesha (2021) reported that the supplementation of wheat flour with a mix of millet and sorghum flour enhances the crude protein and fat of the bread prepared. Also, the difference in the bread nutrient content was due to the difference in chemical composition of wheat flour, millet flour and sorghum flour which are used in the bread process.

Furthermore, calorie value of the flat bread samples was found to be significantly higher with T_3 sample (450.35 kcal/100 g) followed by T_2 (448.02 kcal/100 g), then T_1 (443.42 kcal/100 g) samples. These may be due to the high FF proportion which has a high calorie value (476.75 Kcal) as mentioned above and so, as FF proportion increased and MF proportion decreased, the calorie value of flat bread sample increased. This result is in accordance with Mounika and Sireesha (2021), who recorded a high bread calorie value when the millet flour proportion decreases and sorghum flour increases.

3. Bioactive Total Phenolic Content of Flat Bread Samples

Phenolic compounds in the plants have redox properties which are acting as antioxidants Soobrattee et al. (2005). The bioactive total phenolic content of WF, FF and MF are presented in Fig. (1). Data show that the bioactive total phenolic content of FF recorded the highest value followed by MF, meanwhile WF recorded the lowest (195±0.73, 194±0.63, 84.67±0.21 mg gallic acid/g, respectively). These data are in accordance with Herchi et al. (2014) and Tannous et al. (2020), who mentioned that flaxseeds have a large amount of phenolic compounds. Also, these data are in accordance with Kulkarni et al. (2021) and Nambiar et al. (2011), who mentioned that millet contains high level of phenolic compounds and has anticancer property. Results for bioactive total phenolic content for wheat flour was higher than those observed by Abd El-Aziz (2019), who reported that total phenolic content for wheat flour was 56.5 mg gallic acid/g. Johnsson et al. (2002) clarified that phenolic compounds in flaxseed may function as trapping agents



for chemically induced cancers caused by aromatic carcinogens and serve as a buffer against cell damage.

Fig. (1). Bioactive total phenolic content of wheat, flaxseed and millet flours**.**

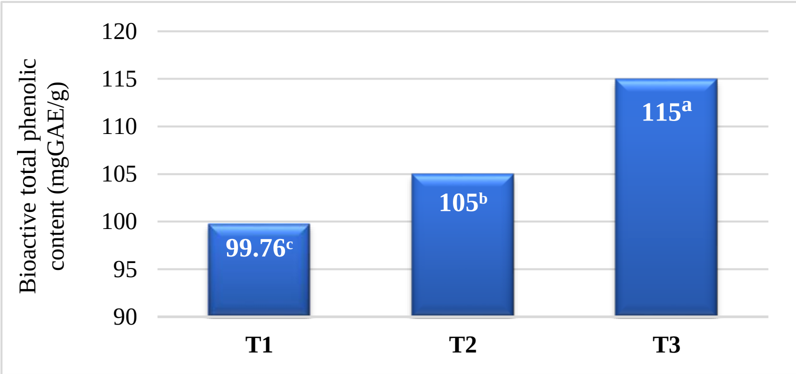


Fig. (2). Bioactive total phenolic content of flat bread samples**.**

Regarding the bioactive total phenolic content of flat bread samples, data illustrated in Fig. (2) show that the highest value of bioactive total phenolic content was observed with T_3 sample (115±0.37 mg gallic acid/g) followed by T_2 sample (105±0.37 mg gallic acid/g), however, the lowest bioactive total phenolic content was noticed with T_1 sample (99.67±0.92 mg gallic acid /g), which means, as FF proportion increased and MF decreased, the bioactive total phenolic content of the bread increased. Results agree with Meral and Dogan (2013) and Gao et al. (2022), who illustrated that as the amount of flaxseed flour increases, the concentration of total phenolic content increases in chinese steamed bread and they pointed out this increment to the high content of antioxidants in flaxseed flour.

5. Alkaline Water Retention Capacity of Flat Bread Samples

The alkaline water retention capacity (AWRC) was identified as the most effective method that assess the bread staling which was the term that describes the time-dependent loss in bread quality (Obadi et al., 2018). The higher values of AWRC means the more freshness of bread because of gelatinized starch, while the lower AWRC values indicates the more crystallized starch and thus loss in freshness (Licciardello et al., 2014). The AWRC of flat bread samples is displayed in Table (3), which shows that, at zero time, the highest significant AWRC value was observed with T_2 sample followed by T_1 and T_3 samples with the same values.

Moreover, a decrease in AWRC values occurred after two and four days for the three flat bread samples, where the significantly highest decrement rate was achieved with T_2 sample followed by T_1 then T_3 samples. Consequently, it could be noticed that all over the four days, T_3 sample showed the lowest decrement rate followed by T_1 sample, whilst T_2 sample recorded the highest decrement rate.

Data in Table (3) clarify the SR values of the flat bread samples. After two days, the highest SR value was found to be with T_2 sample (9.52%) followed by T_1 sample (3.63%), whilst the lowest SR value was observed with T_3 sample (0.35%). However, after four days, the SR value of all flat bread samples was increased, but the lowest rate of increment in the SR values was noticed with T_3 sample.

Table (3). Alkaline water retention capacity and staling rate of flat bread samples.

Flat bread samples	AWRC (%)		
	Zero time	2nd day	4th day
T1	239.00±0.11[b]	230.33±0.17[b]	221.50±0.17[b]
T2	276.67±0.18[a]	250.33±0.23[a]	225.33±0. 23[b]
T3	239.00±0.11[b]	238.17±0.17[b]	232.68±0.25[a]
		SR (%)	
T1	---	3.63%[b]	7.32%[b]
T2	---	9.52%[a]	18.56%[a]
T3	---	0.35%[b]	2.64%[c]

T_1: 10% flaxseed flour+30% millet flour, T_2: 20% flaxseed flour+20% millet flour, T_3: 30% flaxseed flour+10% millet flour. Mean value ± Standard deviation of three replicates, means sharing the same letter in the same column are not significantly different at $p < 0.05$.

Results of SR values agree with Abd El-Khalek et al. (2019), who demonstrated that, as the AWRC values decrease, the SR values will be increased. The decrement in SR value observed with T_3 sample after four days means that the SR has been enhanced. Therefore, it could be concluded that the increment in FF proportion and decrement in MF proportion improved the SR and thus the bread quality.

6. Rheological Properties of Composite Flour Samples

The rheological properties affect the machinability of the dough and the quality of the end product, so the effect of supplementation of WF by FF and MF on the rheological properties were evaluated by the determination of farinograph and extensograph properties. Farinograph is a method that used to measure the rheological characteristics of dough, Farinograph properties results are presented in Table (4).

Water absorption is considered to be indicator for the addition of water to the flour to make the optimal dough. Water absorption value increased as the FF proportion increased and the MF decreased in the composite flour, where the maximum water absorption value was found with the T_3 sample (63%), whereas the minimum water absorption value was noticed with T_1 sample (59%). The high-water absorption value means the presence of more hydrophilic components in the flour matrix **(**Maji and Chowdhury, 2024). Xu et al. (2014) stated that the increase in water absorption value could be due to mucilage of flaxseed, which plays as hydrocolloids and absorbs many time its weight in water. Koca and Anil (2007) pointed out that the increase in flaxseed flour causes an increment in water absorption values and is attributed to the high fiber content in the flaxseed flour. Rosell et al. (2001) notified that the differences in water absorption values are mainly attributed to the hydroxyl groups which are found in the fiber structure which allow more water interactions through hydrogen bond. Also, Mansour et al. (2021) referred that there is a reverse relation between the water absorption values and the amount of millet flour, whereas the water absorption values decrease when the amount of millet flour increases. El-Poraie et al. (2019) found that water absorption values decrease when the millet flour increases from 30 to 40%.

Regarding the arrival time, T_3 sample recorded 2.5 min, where both T_2 and T_2 samples recorded the same arrival time value (2 min), these may due to slower dough development at higher flaxseed flour levels (Xu et al., 2014).

Table (4). Farinograph properties of composite flour samples.

Composite flour samples	Water absorption (%)	Arrival time (min)	Dough development (min)	Stability time (min)	Degree of softening (B.U)
T_1	59.0	2.0	3.0	11.0	30
T_2	61.0	2.0	3.5	10.0	40
T_3	63.0	2.5	4.0	9.0	50

T_1: 10% flaxseed flour+30% millet flour, T_2: 20% flaxseed flour+20% millet flour, T_3: 30% flaxseeds flour+10% millet flour.

Considering the dough development time, which mean the time from the first water addition to the time when the dough reaches the point of consistency (Abd El-Aleem and Al-Azab, 2020), there was an increment in dough development time values as the FF proportion increased and the MF decreased, where T_3 sample exhibited a high value (4 min) followed by T_2 sample and T_1 sample (3.5 and 3 min, respectively). Results are in the same line with those obtained with Koca and Anil (2007), who found an increment in dough development time with the increment in flaxseeds flour ratio, whilst El-Poraie et al. (2019) and Mansour et al. (2021), noticed the decrement in development dough time values with the increment in millet flour ratio in the dough. Tomic et al. (2015**)** reported that the dough development time values range between 1.5-13 min marked that tested flour samples have different levels of gluten structure built in.

The stability time give an indication for dough strength, which means the tolerance of the dough to breakdown during mixing, the higher value the higher dough strength (Wang et al., 2002). T_1 sample showed the highest stability time value, while the lowest stability time value was recorded with the T_1 sample, which means that as the FF proportion decreased and the MF proportion increased in the composite flour samples, the stability time values increased, which means the more dough strength. This result agrees with both Koca and Anil (2007) and Xu et al. (2014), who found that the stability time values decrease with the increment of flaxseed flour, but not in accordance with El-Poraie et al. (2019) and Mansour et al. (2021), who noticed a decrement in stability time values as the millet flour increases.

For the degree of softening, which is an index for the elasticity of dough, it appears that as the FF proportion increased and MF proportion decreased in the composite flour samples, the degree of softening value increased, where the highest degree of softening value was obtained with the T_3 sample followed by T_2 and T_1 samples. The highest degree of softening values means the more dough weakening and that may be due to the dilution of gluten-forming proteins (Koca and Anil, 2007 and Xu et al., 2014).

The extensograph is the standard testing device for determining the stretch-resistance properties of dough which represent the changes in resistance of extension (R) which means the strength of the dough to extension as a function of the extension distance and measured by the maximum height of the curve. Extensibility (E) means the deformation of the dough during extension and before it is breaking and indicated by the length of the curve. The highest extensibility, the more dough extended before it is breaking (Wang et al., 2003). R/E Ratio indicates the ratio of resistance or dough strength to extensibility, which is the extent to which the dough can stretch before breaking and concluded if the curve analyzed has a flat or convex profile. Moreover, the extensograph analysis includes the area under the curve which refer to the dough energy (Miś and Dziki, 2013).

Results of extensogrph parameters given in Table (5) and Fig. (4) clarify that, there was a reduction occurred in R, E and energy values, the higher reduction was found with T_3 sample followed by T_2 and T_1 samples, this means that, R, E and energy of the dough decreased by increasing FF proportion and decrement of MF proportion. Koca and Anil (2007) indicated that increment of flaxseed flour caused a decrement in dough strength, which could be due to dilution of gluten. Furthermore, El-Poraie et al. (2019) and Mansour et al. (2021) detected a decrement in the R, E and energy values as the millet flour replacement increased in the pan bread formulation. Properties of dough affect both the machinability of the dough and the quality of the end product. Rheological properties of dough affect both the machinability of the dough and the quality of the end product. Farinograph is one of the most extensively used methods to measure the rheological characteristics of dough.

Regarding the R/E ratio, T_3 sample recorded the highest value where T_1 sample recorded the lowest value. The increment in R/E Ratio may be due to the polymeric protein structure (El-Poraie et al., 2019). El-Tanahy et al. (2021) indicated that R/E ratio decreases by the increase of millet replacement ratio in the bread formulation. So, it could be concluded that, substitution of wheat flour by a mixture of 30% MF and 10% FF reinforced the R/E ratio.

Table (5). Extensograph properties of composite flour samples.

Composite flour samples	**Resistance to extension (B.U)**	**Extensibility (mm)**	**R/E**	**Energy (cm^2)**
T_1	320	85	3.76	46
T_2	270	65	4.15	31
T_3	240	45	5.33	19

T_1:10% flaxseeds flour+30% millet flour, T_2:20% flaxseeds flour+20% millet flour, T_3:30% flaxseeds flour+10% millet flour.

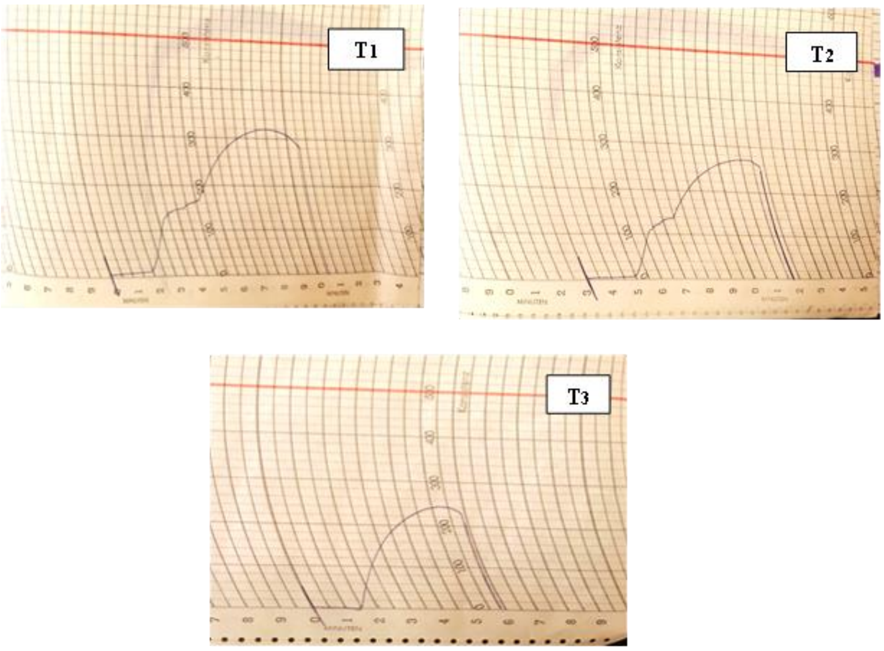


Fig. (4). Extensogram properties of composite flour samples**.**

7. Sensory Evaluation of Flat Bread Samples

Sensory evaluation was estimated in terms of odor, taste, crumb color, crust color, texture and overall acceptability. Obtained data are shown in Fig. (4) and reveal that all sensory attributes were affected by FF and MF proportion in the flat bread samples. It was noticed that the highest overall acceptability scores were found with both T_1 and T_2 samples with no significant differences, followed by the T_3 sample. Taking into consideration that there was no significant difference in taste, crust color and texture scores between T_3 and T_2 samples. The decrement in crumb and crust color scores was due to the increment of FF proportion and decrement of MF proportion in flat bread samples.

Marpalle et al. (2014) detected a decrement in crust color score with the increment of flaxseeds flour ratio. Koca and Anil (2007) informed that the crumb darkness increases as the flaxseed flour level increased. Also, Kaur et al. (2019) found a reduction in the cookie's acceptability scores at higher level of fortification with flaxseed flour. Mansour et al. (2021) reported a decrement in prepared bread sensory attributes scores with the increment of millet flour level in the blend.

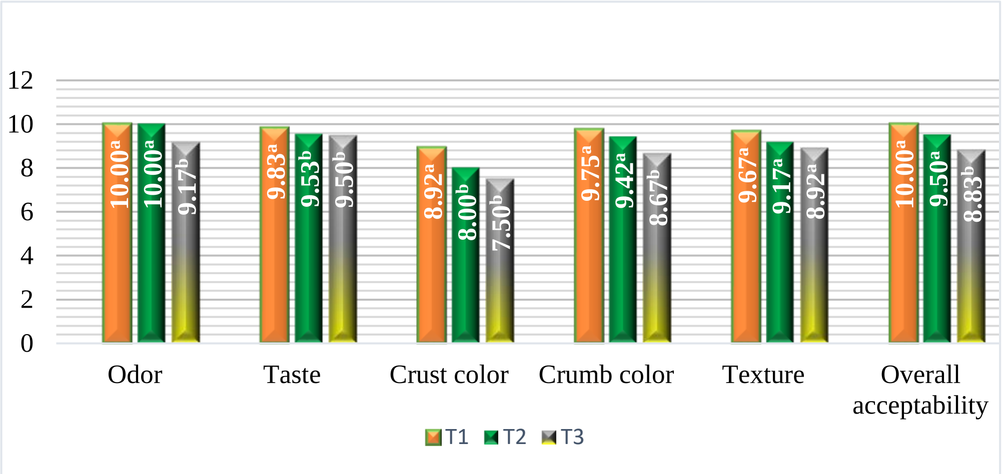


Fig. (4). Sensory properties of flat bread samples.

CONCLUSION

The effect of wheat flour substitute with a mixed flaxseed and millet flours proportion was estimated. It was found that T_3 sample exhibited a good chemical composition, total phenolic content, energy values for the bread prepared. On the contrary, it recorded a lower stability time, resistance to extension and extensibility. The lowest staling rate was set up with T_3 sample followed by T_1 sample. Furthermore, the overall acceptability of the bread prepared from T_3 sample was slightly lower than both T_2 and T_1 samples. Regarding the sensory attributes, the flat bread samples scored an excellent overall acceptability value. Finaly, it could be recommended that the wheat flour could be substituted with a mixing proportion of flaxseed and millet flours to process a healthy beneficial bread for cancer patients with good properties for several uses.

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الإستفادة من بذور الكتان والدخن في إنتاج خبز لمرضي السرطان

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وجد أن الأطعمة النباتية التي تحتوي على المركبات الفينولية لها دور كبير في منع وتطور وانتشار مرض السرطان، وبالتالي فإن إستهلاك مستويات عالية من الأطعمة التي تحتوي على مثل هذه النباتات الغنية بالمركبات الفينولية يساعد على الوقاية وخفض معدلات الإصابة بمرض السرطان. تحتوي بذور الكتان على كمية كبيرة من المركبات الفينولية والتي تتميز بوجود مادة الليجنان، كذلك يعد الدخن مصدرًا جيدًا للمواد الفينولية والتي يمكنها التخلص من الجذور الحرة. تهدف هذه الدراسة إلى تقييم تأثير استبدال دقيق القمح بدقيق بذور الكتان (FF) ودقيق الدخن (MF) على جودة الخبز حيث تم استبدال دقيق القمح [(T_1)10/30, (T_2) 20/20 و(T_3) 30/10] FF/ MF. تم تقييم التركيب الكيميائي والمحتوى الفينولي الكلي والقدرة على الاحتفاظ بالمياه القلوية (AWRC) ومعدل التجلد والتقييم الحسي لعينات الخبز المصنعة والخصائص الريولوجية لخلطات الدقيق المستخدمة في تصنيع الخبز تحت الدراسة. أظهرت النتائج أنه مع زيادة نسبة الـ FF وانخفاض نسبة الـ MF حدث تحسن في قيم كل من البروتين، الرماد، الدهون، الألياف، قيمة الطاقة والمحتوى من الفينولات الكلية. سجلت عينة الـ T_3 قيم جيدة لكل من الـ AWRC ومعدل التجلد متبوعًا بعينة الـ T_1، في حين سجلت العينة T_2 أعلى قيم لمعدل التجلد. تم تسجيل أعلى قيم لكل من وقت ثبات العجين، مقاومة التمدد للعجين وتمدد العجين مع عينة الـ T_1 يليها عينات الـ T_2 وT_3. أيضًا وجدنا أن قيمة القبول الحسي الكلي لعينات الخبز المصنعة متساوية بدون فرق معنوي لكل من عينات الـ T_1 و T_2 يتبعها عينة الـ T_3 بقيمه متقاربة جدًا مع بعضهم البعض. أدى إستبدال دقيق القمح بخليط من دقيق بذور الكتان ودقيق الدخن إلى تحسين المحتوى الفينولي الكلي للخبز المصنع مع خصائص ريولوجية وحسية جيدة.