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# Formulation and Evaluation of Biscuits from Functional Flour Mixture to enhance of antioxidants reflecting on nutrition in Patients

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**Abstract**

Patients are at risk of malnutrition as a result of their, disease and the treatment. Support and intervention Nutrition is important for those patients. The aim of this study was to formulate and evaluate types of biscuits formed from mixture of oat flour, wheat germ, flaxseed, pomegranate peel and wheat flour with different percentages for supporting nutrition for patients. Methods: by using :oat flour, wheat germ, flaxseed, pomegranate peel and wheat flour and their blends for production of biscuits from functional flour blend suitable for nutritional support for patients. Biscuit made of 100% wheat flour was prepared for control sample. For all chemical composition, starch gelatinization, diffraction scanning colorimetry (DSC), colour attributes and sensory properties of biscuits were studied. Oat flour was added to wheat flour at 10, 20, 30, 40 and 50% level. Results: Farinograph parameters showed that water absorption was increased as the percentage of oat flour increased in wheat flour. Diffraction Scanning Colorimetry and Visco-amylograph parameters were significantly affected. Results also showed that Hunter colour parameters (L*, a* & b*) of biscuits were darker as mixing level of oat flour increased, but sample which contained oat flour, wheat germ, flaxseed and Pomegranate peel had an excellent nutritional values and (good) acceptable characters that made it to be suitable for patients for support their nutritional defects due to the treatments( chemo & radiotherapy) with difficulty in having their nutritional requirements. It could be concluded that: oat flour + wheat germ+ flaxseed + Pomegranate peel could be used with wheat flour to formulate biscuit characterized with its good sensorial properties, higher nutritive value, in addition to their positive effect on the rheological characteristics.

*Keywords:* Oat, Wheat Flour, Wheat Germ, Flaxseed, Rheological Properties, Biscuit,

## 1. Introduction

Chronic diseases patients require special nutrition management due to high risk of developing nutritional deficiencies and becoming malnourished. Change in nutritional status may result from the chronic disease itself or from drug treatments that affect it as chemotherapy in cancer patients. Nutritional support and intervention is integral component of chronic disease management [1]. Recently, a considerable importance is given to functional foods, which, in principle, apart from their basic nutritional functions, provide physiological benefits, play an important role in disease prevention or slow the progress of chronic diseases and supporting malnourished patients [2].

Wheat (*Triticum aestivum*) is the most important crop for baking due to its absolute baking performance in comparison to all other cereals [3]. Soft wheat flour has been used for a wide range of commercial baked products. It is usually considered as good quality flour for soft wheat products such as biscuits and cakes with a good quality [4].

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Oat (Avena sativa L.) is a cereal consumed at lower rates than wheat and rice all over the World. However, the dietary fibre content and nutritional value of oat bothare high. Oat contains many essential amino acids (methionine, cysteine, threonine, isoleucine, tryptophan, valine, leucine, histidine, methionine, phenylalanine, and tyrosine) all are necessary for biological process inside human bodies [5]. Also, it contains high antioxidant activity components such as tocopherols, tocotrienols, and flavonoids [6]. Likewise, fibres from oat have a positive effect on health since their consumption has been related to a decreased incidence of several types of diseases as due to its beneficial effects like decreasing the constipation, decreasing the time of intestinal transit, cholesterol and glycaemic levels, trapping substances that can be dangerous for the human organism (mutagenic and carcinogenic agents), stimulating the proliferation of the intestinal flora etc. In addition β- glucans benefits, products derived from oat had a significant content of phenolic compounds and other antioxidants [7-8].

Wheat germ (WG) is widely recognized as a nutritious raw material for incorporation into food product formulations or as a food in its own right. Typical applications are in germ-enriched bread, snack foods, and supplements to breakfast cereals, and for production of wheat-germ oil. Nutritionally, wheat germ is an excellent source of many essential nutrients. Scientific studies showed that, wheat germ is high in energy, fiber and protein. Also, it is a power house of carbohydrates:What's more, wheat germ contains a valuable source of vitamins and minerals. They are vitamin E, folate, zinc, calcium, elenium, mega-3 fatty acids are also important factor which may find in wheat germ. Wheat germ oil, (containing about 8% - 14% oil average 10%), is mainly used in food, medical and cosmetic industries as a source of oil [9]. Relatively a huge quantity of wheat germ is produced annually as a by-product of wheat milling industry in Egypt. In 2012, it was reported that about 120,000 tons wheat germ were produced from wheat milling. This quantity can yield about 12,000 ton wheat germ oil annually. Unfortunately, the whole quantity of the germ produced is currently utilized in the production of animal fodder [10]. It is advisable therefore that this by-product would be rather utilized for oil production. Finally: we can say that: Wheat germ consists of huge amount of nutrients, which is a good explanation for its beneficial effects on people's health. Flaxseed is mainly considered as oilseed crop. Moreover, the other nutritional parameters than its oil content, make it more favourable choice for food technologist to develop functional foods. Flaxseed contains good amount of α-Linolenic Acid (ALA), omega-3 fatty acid, protein, dietary fibre, lignan, specifically Secoisolariciresinol diglucoside (SDG). Their health benefits are mainly due to their content of omega-3 fats, lignans and fibre and omega-3 fatty acid, α - linolenic acid (ALA) [11-12]. Flaxseed is rich in lignans which have estrogenic activities as well as antioxidant and anticancer activities [13-14]. It is emerging as an important functional food ingredient because, it provides oil rich in omega-3, digestible proteins, and lignans. In addition to being one of the richest sources of α-linolenic acid oil and lignans, flaxseed is an essential source of high quality protein and soluble fibre and has considerable potential as a source of phenolic compounds [15-16]. Plant-based ALA fatty acids are proven to have heart health benefits and are linked to a lower risk of stroke.

There has been a virtual explosion of interest in the pomegranate as a medicinal and nutritional product because of its multifunctionality and its great benefit in the human diet as it contains several groups of substances that are useful in disease risk reduction. As a result, the field of pomegranate research has experienced tremendous growth [17]. Pomegranate fruits peel is an inedible part obtained during processing of pomegranate juice. Pomegranate peel is a rich source of tannins, flavonoids and other phenolic compounds [18]. It could be illustrated that pomegranate fruits peel powder (PPP) protein contained a much higher content from lysine, leucine, aromatic fatty acids (phenylalanine and tyrosine), threonine and valine than the reference protein pattern and therefore the amino acid score of these IAAs was higher than 100. On the other hand, the PPP had slight lower contents of amino **acids** containing sulphur (methionine and cysteine) and isoleucine which having amino acid score of 95.7 and 93.2; respectively. Therefore, the incorporation of available inexpensive pomegranate by-products; peel, powder in Egypt into the foodstuff; especially which deficient in amino acids containing sulfur, aromatic amino acids, leucine and isoleucine has a great economic value and a good standpoint in food technology and human nutrition [17-18]. Pomegranate (*Punica granatum L.*) peel, a by-product of juice processing industries was reported to contain a series of bioactive compounds, minerals and fibre for a wide range of dietary requirements [19]. The waste fraction of fruit holds up relatively higher total phenolic concentration (1.261%) in addition to its properties as promising source of crude fibre (12.17%) and inorganic residues that embrace health promotive features like prevention the development of cardiovascular disorders as well as its hypoglycaemic, apoptotic, anti-inflammatory, anti-parasitic and as apre-biotic [20-21].

Biscuits are the most popular bakery food product consumed by nearly all levels of society. Flour, fat, water, and sugar are the main components in a biscuit formulation. Fats are needed in biscuit manufacturing because they have suitable plasticity properties, allowing the air to be incorporated during dough formation and enabling the dough to withstand the high temperatures reached during baking and hold its shape for longer [22].The present work aimed in this study was to formulate and evaluate types of biscuits formed from mixture of oat flour, wheat germ, flaxseed, and pomegranate peel and wheat flour for supporting nutrition for these types of patients. In the study the impact of incorporating wheat flour, whole oat flour, wheat germ, flaxseed, pomegranate peel on the biscuit quality. Consequently, biscuit containing whole oat flour at different ratios were prepared. Proximate composition, physical properties, diameter, thickness, texture, diffraction scanning colorimetry and rheological properties. The objectives of the present study were to production of biscuits rich of antioxidants from different mixture of oat flour, wheat germ, flaxseed, pomegranate peel and wheat flour reflect on Patients feeding and investigating the effect of processing methods on the physico-chemical properties change of the biscuits**.**

## Materials and methods

### Materials

#### Raw Materials

Wheat flour (WF), whole oat flour (WOF), Wheat germ (WG), Flaxseed, Pomegranate peel, Skimmed milk, sugar, butter, baking powder and vanilla were purchased from local markets, Cairo, Egypt.

### Methods

#### Preparation of Raw Materials

Wheat flour (WF), Whole Oat flour (WOF), Wheat germ (WG), Flaxseed and Pomegranate peel has been dried in an air oven (SHELLAB - Model 1350FX –SHELDON)manufacturing, INC- Made in USA) at 45 ± 2°C for 4 hrs, then grinded to powder and milling using a locally Milling machine, then kept in plastic sachets.

#### Thermal Properties

Starch gelatinization was studied in a differential scanning calorimeter (Mettler Toledo DSC 823-E, Switzerland) under oxygen free N2 flow rate of 50 ml/min, using 1:3 (w/v) starch-water mixtures. The samples were hermetically sealed in a pre-weighed aluminium pan at room temperature and re-weighed in a microbalance. After sealing the pan and leaving it to equilibrate for about 1 h, the samples were heated from 30 to 110°C at the rate of 10°C /min. An empty pan was used as a reference. The temperatures of the characteristic transitions, onset temperature (To), peak temperature (Tp) and end temperature (Te) were recorded and the temperature range (Te-To, ΔT) was calculated. The enthalpy (ΔHG) of the transition was expressed as mJ/g on a dry weight basis.

#### Rheological Properties of Dough

#### Pasting Properties of Flours

The viscoelastic properties of raw materials (skimmed milk, Flaxseed, wheat germ, and Oat flour) and their blend (50% oat+30% wheat germ+15% pomegranate peel +5% Flaxseed) flours as shown in table (3) were examined using an amylograph test according to the method described in AACC [23].

#### Farinograph Parameters of Dough

Farinograph parameters of dough were carried out according to AACC [23]. The samples were tested by bra- bender farinograph (model No. 178507) for determining water absorption, arrival time, dough development time, dough stability, mixing tolerance index and degree of weakening.

#### Preparation of Mixture from Raw Materials

Wheat flour (WF) of 72% extraction was well blended with whole oat flour(WOF), wheat germ (WG), flaxseed, pomegranate peel, Skimmed milk, sugar, butter, baking powder and vanilla to produce individual to manufacture of biscuit as shown in table (1). All samples were stored in airtight containers and kept at 3-4 º C until required.

#### Preparation and Evaluation of Biscuit

The biscuit was prepared by mixing 100 g wheat flour and their blends containing wheat flour, whole oat flour, wheat germ, flaxseed, and pomegranate Peel (table 1). Biscuit formula was as follows: 100g flour, 40 g sucrose, 28 g butter, 0.5 g salt, 1.11 g baking powder and 1 g vanilla. Biscuit preparation: fats and sugar were mixed until fluffy. Powdered skimmed milk were added while mixing and then mixed for a total of about 30 min. Vanilla, baking powder and salt were mixed thoroughly and added to the cream mixture where they were all mixed together to form a dough. The dough was rolled and cut into shapes. Baking was carried out at 180ºC for 20 min. Biscuit samples were cooled and stored in polyethylene bags until needed

#### Colour Determinations

Objective evaluation of colour for raw materials (Skimmed milk, Flaxseed, Wheat germ, Peel of pomegranate and Oat flour) were measured. Hunter a*, b* and L* parameters were measured with a colour difference meter using a spectro- colorimeter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized each time with white tile of Hunter Lab Colour Standard (LX No.16379): X= 72.26, Y=

81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16) [24].

**Chemical Composition**

Moisture, ash, crude protein, fat and crude fibre contents were determined in raw materials (Skimmed milk, Flaxseed, Wheat germ, Peel of pomegranate and Oat flour) according to the methods outlined in A.O.A.C. [25]. Carbohydrates were calculated by difference as mentioned as follows: Carbohydrates = 100 – (% protein + % fat + % ash + % crude fibre).

**Determination of Fatty Acid Profile of Wheat Germ Samples by GLC**.

The fatty acids of lipid were estimated for selected isolates as methyl esters according to Luddy et al. [26] using gas chromatography: (Perkin Elmer Auto System XL) with capillary column containing silica ZB-Wax (60 m x 0.32 mm i.d) and equipped with flame ionization detector (FID), Oven temperature was maintained initially at 50 ºC and programmed from 50 to 220 ºC for 2 min at rate, held at 50 ºC to 4 ºC/min, injector temp 230 ºC, detector temp 250 ºC and carrier gas: helium, flow rate: 1 ml/min. Fatty acid methyl esters were identified and quantified by comparison of their retention time with authentic standards.

**Sensory Evaluation of Biscuit**

The subjective evaluation of biscuit was carried out for the external sensory characteristics. Biscuits were evaluated for colour, appearance, flavour, taste, texture, and overall acceptability according to the method described by Hegazy et al. [27] to find out the most suitable treatment for cookies production.

**Statistical analysis**

The obtained results were evaluated statistically using the analysis of variance as reported by McClave and Benson [28].

Table 1. D**ifferent quantities of ingredients in different biscuits blends**

| Ingredients (gm) | Control | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Wheat flour (WF) | 100 | 90 | 80 | 70 | 60 | - |
| Whole Oat flour (WOF) | -- | 10 | 20 | 30 | 40 | 50 |
| Wheat germ (WG) | - | - | - | - | - | 30 |
| Flaxseed | - | - | - | - | - | 15 |
| Pomegranate Peel(PP) | - | - | - | - | - | 5 |
| Skimmed milk powder | 5 | 5 | 5 | 5 | 5 | 5 |
| Butter | 28 | 10 | 10 | 10 | 10 | 10 |
| Baking powder | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 |
| vanilla flavour (ml) | 1 | 1 | 1 | 1 | 1 | 1 |
| Sugar | 40 | 15 | 15 | 15 | 15 | 15 |
| Salt | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

**Results and discussion**

**Chemical Composition of raw materials**

Data presented in Table (2) showed and compared chemical composition of flours from skimmed milk, flaxseed, wheat germ, peel pomegranate and oat. Wheat germ was characterized with their higher contents of protein (29.79%) than skimmed milk, flaxseed, peel pomegranate and oat. Flaxseed was higher in fat content (34.23%) compared with skimmed milk, wheat germ, peel pomegranate and oat flour. Peel pomegranate was contained higher percentage of fibre (14.40%) than skimmed milk, flaxseed, wheat germ and oat. Oat flour was the highest in the content of total carbohydrates (79.14 %) compared with other flours. The obtained results were in agreement with those reported by Saleh et al.[29] and Rawat and Darappa [30].

**Table 2. Chemical composition of raw materials (on dry wet basis)**

| Samples | Components (%) | | | | | |
|---|---|---|---|---|---|---|
| | **Moisture** | **Protein** | **Fat** | **Fibre** | **Ash** | **Total carbohydrate** |
| Skimmed milk | 2.69±0.10 | 22.11±0.15 | 3.02±0.06 | - | 4.55±0.03 | 70.32±1.12 |
| Flaxseed | 5.05±0.12 | 17.03±0.12 | 34.23±0.25 | 6.37±0.22 | 3.77±0.06 | 38.6±0.35 |
| Wheat germ | 6.39±0.16 | 29.79±0.24 | 8.56±0.16 | 1.52±0.08 | 4.73±0.09 | 55.4±0.49 |
| Peel pomegranate | 7.65±0.09 | 7.19±0.19 | 0.56±0.001 | 14.40±0.19 | 4.80±0.02 | 73.05±0.78 |
| Oat | 7.84±0.06 | 12.29±0.17 | 5.82±0.11 | 0.91±0.001 | 1.84±0.001 | 79.14±0.69 |

**Colour attributes of raw materials**

Colour attributes of raw materials (skimmed milk, flaxseed, wheat germ, peel pomegranate and oat are shown in Table (3). Table (3) showed that skimmed milk characterized with its higher lightness (L=93.20) redness (a=-2.38), and yellowish (b was 27.27). While peel pomegranate had the lowest lightness (L=31.80), redness (a=10.82) and yellowness (b) decreased slightly to 12.84 if compared with other raw materials. Such findings are in-agreement with authors [31-34].

**Table 3.Hunter colour parameter of raw materials**

| Samples | L | a | b |
|---|---|---|---|
| Skimmed milk | 93.20±1.15 | -2.38±0.03 | 27.26±0.11 |
| Flaxseed | 48.45±1.29 | 8.00±0.21 | 21.62±0.17 |
| Wheat germ | 71.08±1.35 | 4.49±0.15 | 30.18±0.20 |
| Peel pomegranate | 31.80±1.62 | 10.82±0.12 | 12.84±0.12 |
| Oat | 78.25±0.14 | 2.97±0.11 | 17.19±0.10 |

**Viscoamylograph measurements of dough containing wheat germ, oat and flaxseed**

The amylograph measures the change in viscosity of a flour-water suspension as the temperature is raised at a uniform rate. The height of the amylogram peak is related to the gelatinization characteristics of the starch and the α-amylase activity [35]. Oat flour, wheat germ and mixture from oat flour, wheat germ, peel pomegranate and flaxseed were rheologically evaluated by viscoamylograph for heat of transition, maximum viscosity and temperature of maximum viscosity as presented in Table (4). Results showed that: oat flour, wheat germ and mixture had 63 °C, 85.5°C and 84°C; 93°C, 94.5°C and 90°C; 4580, 220 and 140BU for heat of transition, temperature of maximum viscosity and maximum viscosity, respectively. The effect of replacing wheat germ, pomegranate peel and flaxseed with oat flour on the parameters of amylograph test led to decreased heat of transition, temperature of maximum viscosity and maximum viscosity (Table 4).

**Table 4. Amylograph parameter of raw materials**

| **Samples** | **Transmission temperature (°C)** | **Temperature of peak viscosity(°C)** | **Peak viscosity (BU)** |
|---|---|---|---|
| Oat | 63 | 93 | 4580 |
| Wheat germ | 85.5 | 94.5 | 220 |
| Mixture from 50%oat +30% wheat germ+15% +5% flaxseed | 84 | 90 | 140 |

**Farinograph Parameters**

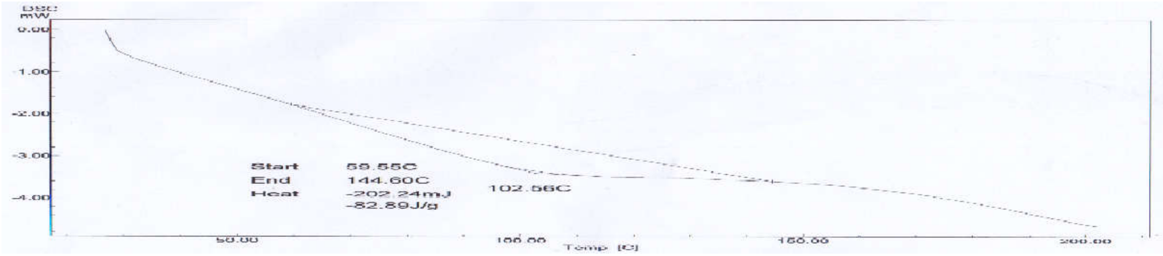
The effect of oat flour supplementation on rheological characteristics of Wholemeal Wheat flour is summarized in Table 5. It can be noticed that water absorption (WA) increased with increasing level of oat flour from 68.1% (control sample) to 74.9% (sample with 50% substitution of oat flour). Adding 20, 30, 40 and 50% oat flour increases WA to 3.5, 5.7, 8.2 and 10.0 % respectively as compared with the control dough. This increase may be referred to high protein and fibre contents of oat flour compared to wholemeal wheat flour. Protein and dietary fibre tend to bind more water and dietary fibres characterized by its higher water holding capacity. Protein and dietary fibre in oat flour interact with wheat flour ingredients and water, consequently stability of dough increased. WA is associated with a number of factors including the protein and non-starch polysaccharides contents in the dough and higher water absorption is attributed to higher protein and fibre contents especially higher molecular weight proteins and non-starch polysaccharides [36]. The explanation of this phenomenon is based partly on the fact that the fibre structure contains a large number of hydroxyl groups, which interact with the hydrogen bonds of water [37-38]. Dough development time (DDT) increased from 2.0 to 4.0 min with 50% incorporation of oat flour. During this phase of mixing, water hydrates, the flour components and the dough are developed [39]. Similar trends in DDT were observed by Borchani *et al.* [40]. Increasing of DDT could be attributed to the fibre-gluten interaction, which prevents protein hydration [38]. Dough stability (DS) is known to be related to the quality of the protein matrix, which is easily damaged by the incorporation of other ingredients [41]. Addition of oat flour leads to (resulting in) a decreasing of DS from 7.0 to 3.0 min. These observations were similar with those obtained by [42-14] for orange by-products commercial potato fibre and rice bran supplemented wheat dough. This effect could be explained by a higher interaction between dietary fibre, water and flour proteins [40]. From the measurements it was also observed that increasing level of oat flour resulted in decrease of dough weakening (DW) and mixing tolerance index (MTI). These results are in agreement with findings by [42, 39] where they were substituted wheat flour by citrus by-products. Reduction of MTI can be explained by interactions between fibre and gluten [43, 37].

**Table 5. Farinograph parameters of raw materials**

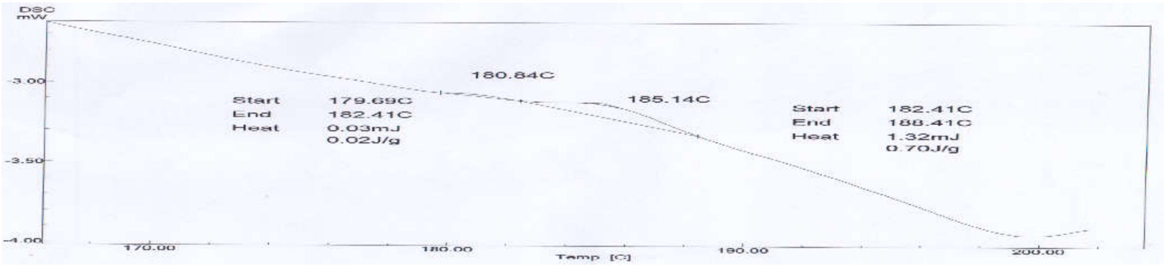
| Samples | Water absorption (%) | Arrival time(min) | Dough development time(min) | Dough stability (min) | Mixing tolerance index(BU) | Dough weakening (BU) |
|---|---|---|---|---|---|---|
| Control (100% (Wheat flour ) | 68.1 | 1.5 | 2.0 | 7.0 | 0 | 50 |
| 20% Oat +80% wheat flour | 70.5 | 2.0 | 2.0 | 6.0 | 40 | 100 |
| 30% Oat +70% wheat flour | 72.0 | 2.5 | 3.0 | 5.0 | 60 | 110 |
| 40% Oat+60% wheat flour | 73.7 | 2.0 | 2.5 | 4.0 | 80 | 120 |
| 50% Oat +50% wheat flour | 74.9 | 2.5 | 4.0 | 3.0 | 100 | 160 |

**Thermal properties**

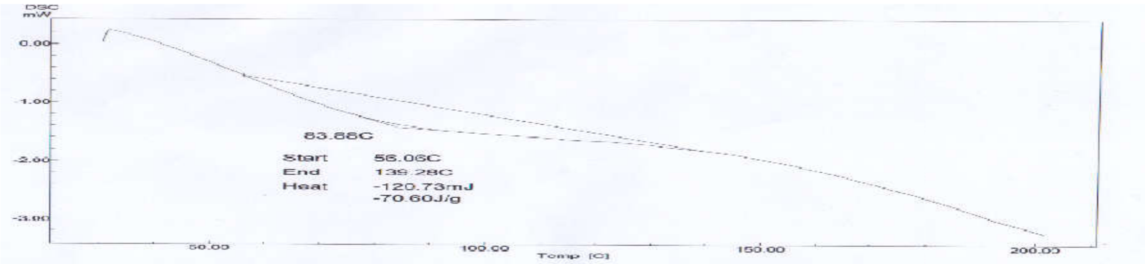
Figure (1) is showing gelatinization properties determined using DSC. DSC parameters recorded were onset To, Peak Tp, Final Te gelatinization temperatures, gelatinized temperature range (Te-To) gelatinization and enthalpy ΔH. Gelatinization temperatures and enthalpies associated with gelatinization endotherms varied between starches. To was 59.55, 179.69, 56.06, 30.45 and 108.53 °C, Tp was 102.56, 185.14, 83.88, 79.87 and 120.83 and Te was 144.60, 182.41, 129.38, 129.44 and 130.98 for control (WF), WF with 20% OF, WF with 30% OF, WF with 40% OF and 50% OF+30% WG+15% flaxseed +5%PP, respectively. Gelatinization temperature is considered a parameter of crystallite perfection because amylopectin plays a major role in starch granule crystallinity, the presence of amylose lower the melting temperature of crystalline regions and the energy for starting gelatinization [44]. More energy is needed to intimate melting in the absence of amylose-rich amorphous regions. This correlation indicated that starch with higher amylose content has more amorphous region and lesscrystalline, lowering gelatinization temperature and endothermic enthalpy. Native and mixed starches with the same amylose contents as native starches showed clearly different gelatinization onset and peak temperature. The difference in gelatinization properties between native and mixed starches is due to differences in homogeneity [45]. Fredriksson et al.[46] reported that a wide temperature range implies a large amount of crystals with varied stability. Also, DSC parameters are also influenced by the molecular structure of the crystalline region corresponds to the distribution of amylopectin short chain and not to the propagation of the crystalline region which corresponds to the amylase [47].




Control

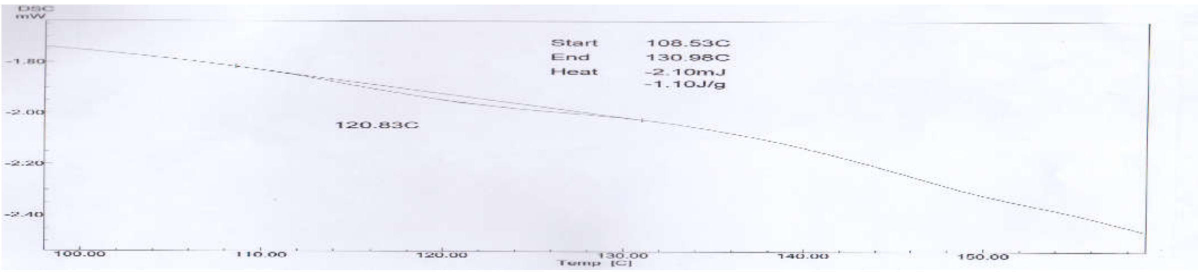



20% WOF+80% WF




30 % WOF +70% WF


40% WOF+60% WF




**50% WOF+30% WG+15% flaxseed +5%** PP

Fig1. Effect of adding WOF, WG, PP and flaxseed to WF on DSC

**Fatty acid composition of wheat germ**

The composition of wheat germ fatty acids was determined by GC and presented in table (6). Wheat germ flour contained 19.88% saturated fatty acids (SFA), 78.67% unsaturated fatty acids (USFA) consisting of

17.36% monounsaturated fatty acids (MUFA) and 61.31% of polyunsaturated fatty acids (PUFA). Linoleic acid, the essential fatty acid, is one of the most important polyunsaturated .A striking feature of wheat germ lipids was the relatively high level of polyunsaturated fatty acids (PUFA), especially linoleic fatty acid which was estimated at higher levels (54.37%) fatty acids in human food because of its prevention of cardiovascular heart disease (CHD). With regard to the issue of fatty acids, our data are in accordance with those of Ramadan *et al.*[47] which show that the proportion of linoleic followed by oleic and palmitic as the major fatty acids, which together comprise more than 92 g/100g of the total identified. Such findings are in-agreement with [10, 12, 49, 50].

**Table 6. Fatty acid composition of wheat germ (**for important of fatty acids of germ in formula )

| Fatty acids | | Relative % |
|---|---|---|
| Caproic acid | C6:0 | 0.26 |
| Caprylic acid | C8:0 | 0.37 |
| Capric acid | C10:0 | 0.70 |
| Myristic acid | C14:0 | 0.26 |
| Pentadecylic acid | C15:0 | 0.06 |
| Palmitoleic acid | C16:1 | 0.15 |
| Palmitic acid | C16:0 | 17.01 |
| Linoleic acid | C18:2 | 54.37 |
| Oleic acid | C18:1 | 14.94 |
| Linolenic acid | C18:3 | 6.84 |
| Stearic acid | C18:0 | 0.92 |
| Arachidonic acid | C20:1 | 2.27 |
| Arachidic acid | C20:0 | 0.18 |
| Heneicoscanoic | C21:0 | 1.54 |
| Behenic acid | C22:0 | 0.12 |

**Colour attributes of biscuits**

Colour is one of the most important sensory attribute that affect directly the consumer preference of any product. Special attention should be given to bakery products to attract the consumer attention. The colour parameters (L*, a*and b*) of biscuit samples were evaluated and presented in table (7). Scale range of whiteness (L*) is from 0 black to 100 white; a* scale extends from a negative value (green hue) to a positive value (red hue) and b* scale from negative blue to positive yellow. Oat flour were darker than wheat flour and mixture from wheat biscuits with oat flour where lightness (L*) and yellowness (b*) decreased but redness (a*) increased as rate of oat flour used in mixture increased. All formulas caused a noticeable darker colour for the crust of biscuits (L* and b* values were decreased) and the redness (a values) of crust were increased as a result of oat flour addition compared to control sample (100% wheat flour). Such findings are in agreement with [31-34].

**Table 7.** Effect of oat, wheat germ, flaxseed, pomegranate peel flour addition on color measurements of biscuit samples compared to control biscuit

| Biscuit samples | L | a | b |
|---|---|---|---|
| **Control** | 65.10$^a$±2.11 | 6.80$^d$±0.96 | 32.50$^b$±1.55 |
| **1** | 60.80$^b$±1.31 | 10.80$^c$±0.47 | 35.71$^a$±1.49 |
| **2** | 55.41$^d$±1.34 | 12.50$^a$±0.66 | 36.15$^a$±1.77 |
| **3** | 58.20$^c$±1.66 | 11.00$^b$±0.79 | 35.00$^a$±1.17 |
| **4** | 58.33$^c$±2.61 | 11.10$^b$±0.88 | 35.50$^a$±1.95 |
| **5** | 38.40$^e$±2.11 | 13.20$^a$±1.01 | 27.19$^c$±1.65 |
| **LSD at 0.05** | 2.662 | 1.101 | 1.958 |

**Where: 1, 2, 3, 4 and 5 see table 1**

**Proximate composition of biscuits**

Proximate composition of biscuits made from different mixing level with oat flour (20, 30 and 40%) were presented in Table (8).The results of the proximate chemical analysis indicated that: biscuit from 100% wheat flour containing 0.33% ash, 10.46 % crude protein, 28.37% fat, 0.77% fibre and 60.07% carbohydrate. Therefore, increasing mixing level of oat flour with wheat flour in formula of biscuit lead to an increase the nutritional value of biscuits where protein, fibre, ash and carbohydrate ranged between (10.46 -11.90%), (0.77-1.21%), (0.33- 1.25%) and (60.07-75.18%) for biscuits, resp ectively. While addition wheat germ flaxseed and Pomegranate peel to dough of biscuits lead to an increase of protein, fat, ash and fibre with decreased of total carbohydrates.

**Table 8.** Gross chemical composition of control biscuit and experimental biscuits

| Composition | Ash | Protein | Fat | Fibre | Carbohydrates |
|---|---|---|---|---|---|
| Control | 0.33$^e$±0.30 | 10.46$^d$±0.21 | 28.37$^a$±1.13 | 0.77$^f$±0.03 | 60.07$^b$±2.66 |
| 1 | 0.75$^{de}$±0.31 | 11.38$^c$±0.19 | 10.40$^c$±1.23 | 0.92$^e$±0.06 | 76.55$^a$±2.84 |
| 2 | 0.97$^d$±0.22 | 11.65$^{bc}$±0.30 | 10.43$^c$±1.11 | 1.07$^d$±0.05 | 75.88$^a$±2.65 |
| 3 | 1.25$^c$±0.35 | 11.90$^b$±0.24 | 10.46$^c$±1.18 | 1.21$^c$±0.03 | 75.18$^a$±2.51 |
| 4 | 1.75$^b$±0.29 | 12.05$^b$±0.25 | 10.49$^c$±1.21 | 1.36$^b$±0.02 | 74.35$^a$±2.68 |
| 5 | 2.00$^a$±0.39 | 15.43$^a$±0.27 | 17.34$^b$±1.19 | 3.21$^a$±0.03 | 62.02b±2.33 |
| LSD at 0.05 | 0.42 | 0.304 | 1.237 | 0.072 | 2.985 |

**Where: 1, 2, 3, 4 and 5 see table 1**

**Sensory evaluation**

Sensory evaluation is considered one of the limiting factors of consumer acceptability for organoleptic properties including colour, taste, odour, texture, appearance and overall acceptability. The effects of oat flour, wheat germ, flaxseed and Pomegranate peel on sensory characteristics of biscuits are presented in table (9). With the increase in the level of oat flour in the formulation, the sensory scores for colour, taste, odour, texture, appearance and overall acceptability of biscuits decreased. Data indicated that a significant ($P<0.05$) changes were found in all properties for all formulated products. Table (9) showed that biscuit made from mixture containing oat flour + wheat germ+ flaxseed + Pomegranate peel had lower scores for most properties compared to the other tested products. Besides it showed the lowest score for overall acceptability for biscuit compared to control. Finally, the results showed that in all the sensory qualities that increase the proportion of oat flour about 30% less than in the sensory qualities, especially colour and appearance. Also, the results for organoleptic properties are in agreement with work done by zaki et al.[51]. From the sensory acceptability rating, it was concluded that biscuits were made from oat flour + wheat germ+ flaxseed+ Pomegranate peel could be incorporated to all levels used in this study to wheat flour in the formation of biscuits without significantly affecting on sensory quality.

**Table 9.** Sensory evaluation of control biscuit and experimental biscuits

| Biscuit samples | Colour (20) | Taste (20) | Odour (20) | Texture (20) | Appearance (20) | Overall acceptability (100) |
|---|---|---|---|---|---|---|
| **Control** | $18.95^{a}±1.01$ | $18.60^{a}±0.85$ | $19.50^{a}±1.10$ | $18.70^{a}±1.11$ | $19.60^{a}±1.33$ | $95.15^{a}±2.14$ |
| **1** | $18.80^{a}±0.96$ | $18.50^{a}±0.88$ | $19.50^{a}±1.19$ | $18.90^{a}±1.09$ | $19.10^{a}±1.26$ | $94.70^{a}±2.19$ |
| **2** | $18.51^{a}±1.03$ | $17.66^{a}±0.69$ | $19.30^{a}±1.06$ | $19.05^{a}±1.09$ | $18.70^{a}±1.39$ | $93.00^{a}±2.33$ |
| **3** | $18.72^{a}±1.02$ | $17.50^{b}±0.78$ | $19.10^{a}±1.13$ | $19.40^{a}±0.99$ | $18.50^{a}±1.17$ | $93.00^{a}±2.66$ |
| **4** | $18.61^{a}±0.83$ | $16.30^{c}±0.89$ | $19.10^{a}±1.09$ | $19.60^{a}±1.17$ | $17.00^{b}±1.13$ | $90.41^{b}±1.86$ |
| **5** | $13.50^{b}±0.91$ | $14.00^{d}±0.77$ | $17.30^{b}±1.17$ | $16.50^{b}±1.06$ | $13.50^{c}±1.22$ | $74.20^{c}±2.19$ |
| **LSD at 0.05** | 1.052 | 0.995 | 1.323 | 1.288 | 1.445 | 3.655 |

**Where: 1, 2, 3, 4 and 5 see table 1**

## Conclusion

In general, it could be concluded that: oat flour + wheat germ+ flaxseed + Pomegranate peel could be used with wheat flour to formulate biscuit characterized with its good sensorial properties, higher nutritive value, in addition to their positive effect on the rheological characteristics. It can be used in improving the nutritional defects that affect patients with cancer head and neck before, during and after treatment with chemotherapy and radiotherapy. This study will be conducted later on and published on another study.

## Conflect of intrest

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