Preparation and Evaluation of Biscuits Supplemented with some Natural Additives for Children and Adolescents Feeding

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Abstract: To prepare and evaluate a healthy biscuit for reducing malnutrition diseases such as anemia and osteoporosis. Several models of two formulas were proposed by using five types of natural supplements; pumpkin (P), yellow corn germ (G), white kidney bean (Wb), rice bran (R) and rosella flower (K) to supplement wheat flour 72% extraction (W). The results of the sensory evaluation showed that the biscuits supplemented from the following mixtures: PG (80%W+10%P+10%G), PR (80%W+10%P+10%R), PWb (80%W+10% P +10%Wb), WbG (80%W +10%Wb+10%G) and WbR (80%W+10%Wb+10%R)as a duple mixes or T3 (75%W+10%R+5%Wb+5%G+3%P+2%K) as a multi mix had a very good degree of preference, so they were selected to be a chemically and physically evaluate and study the storage stability of the produced biscuits. The results of the chemical analysis indicated that all types of supplemented biscuit had high content of protein, fat, ash, crude fiber and total calories. They have a high mineral content (*i.e*., iron, zinc, calcium, manganese and magnesium), vitamins contents (*i.e*., A, E, K, B1, B_2, B_3, B_6 and B_9), total essential amino acids, biological value, protein efficiency ratio, total unsaturated fatty acids compared with the control. The color properties of the samples containing the pumpkin were improved. The spread factor and hardness of all types of supplemented biscuits was higher than those for the control. All types of supplemented biscuits were the highest in contribute of most of Recommended Dietary Allowances for a studied previous nutrient for children and adults. So it could be recommended to incorporate the investigated nutritional sources in bakery products to obtain healthy bakery products having high biological values, especially for resistance to anemia and osteoporosis due to the high content of the required nutrients.

Keywords: Biscuit, Natural additives, Nutritional value and Storage stability

INTRODUCTION

Malnutrition affects physical growth, morbidity, mortality, cognitive development, reproduction and physical work capacity, and it consequently impacts on human performance, health and survival. It is an underlying factor in many diseases for both children and adults and is particularly prevalent in developing countries (Pelletier and Frongillo, 2003; Branca *et al.,* 2015 ; Alicke *et al*., 2017; Bates *et al*., 2017; Getahun *et al*., 2017; Suchdev, 2017). However, eating healthy foods is an important part of a healthy lifestyle and healthful nutritional practices need to be educated during childhood and early adolescence (Raghunatha-Rao *et al*., 2007; Wertich, 2013). Mineral deficiencies, especially of iron, calcium, and zinc, have a negative effect on human health and may lead to conditions such as iron deficiency anemia, rickets, osteoporosis, and diseases of the immune system (Yanagisawa, 2004; Pettifor *et al*., 2010; Al Rifai *et al*., 2016; Goulder *et al*., 2016; No, 2015; Hwalla *et al.*, 2017; Pan *et al.*, 2017; Wander *et al*., 2017).

School feeding is defined here as the provision of food to school children. There are as many types of programs as there are countries, but they can be classified into two main groups based on their modalities: (1) in-school feeding, where children are fed in school; and (2) take-home rations, where families are given food if their children attend school. In-school feeding can, in turn, be divided into two common categories: (1) programs that provide meals; and (2) programs that provide high-energy biscuits or snacks (Gelli and Daryanani, 2013; No, 2015).

Adolescence is the only time following infancy when the rate of physical growth actually increases. This sudden growth spurt is associated with hormonal, cognitive, and emotional changes that make adolescence an especially vulnerable period of life. First, (11-14 years of age) there is a greater demand for calories and nutrients due to the dramatic increase in physical growth and development over a relatively short period of time. Second (15-17 years of age), adolescence is a time of changing lifestyles and food habits that affect both nutrient needs and intake. Third (18-21 years of age), adolescent drive for individuation means more opportunity to assert food choices and expand or narrow healthy options (Stang and Story, 2005; McNeely and Blanchard, 2010; Sawyer *et al*., 2012; UNICEF, 2015).

Wheat (*Triticum aestivum* L.*)* bread is considered to be nutritionally poor and the supplementation of wheat flour with high protein- content flours is a powerful tool to improve the nutritional quality of bakery products (Sabanis and Tzia, 2009; Shahine-Fatma *et al.,* 2013; Siddiq *et al*., 2013). Protein-enriched food from plant sources are rich in lysine, a limiting amino acid in wheat flour (Day, 2013; Chardigny and Walrand, 2016).

Dry beans occupy an important place in human nutrition, especially among the low - income groups of people in developing countries. The kidney bean (*Phaseolus vulgaris* L.) is one of the most important food legumes, consumed worldwide as pods of green beans or culinary processed seeds of dry beans. It is a good source of protein and rich in iron, manganese, phosphorous, copper, magnesium, vitamin E, and folate (B9). Furthermore, it has high content of soluble dietary

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fibers such gums, beta glucans, and pectin (Osorio-Diaz *et al*., 2003; Abdel- Gaber *et al*., 2006; Câmara *et al*., 2013; Brigide *et al*., 2014; El-Syiad and Hassan, 2014). Kidney beans have several health benefits. The bean consumption is associated with a reduced risk of cardiovascular disease, diabetes mellitus, obesity, and diseases of the digestive tract. These benefits are due to the presence of free cyclitol, soluble carbohydrate, protein, and antioxidants (Ribeiro *et al*., 2011; Singh *et al*., 2017). Furthermore, kidney beans have the availability of minerals like zinc and calcium and some antioxidants in higher quantities than soybeans, peanuts, and other legumes (Trinidad *et al*., 2010; Ntatsi *et al.*, 2018).

Roselle (*Hibiscus sabdariffa* L.) is a very important herbaceous crop can be consumed for improvement the health condition due to its excellent nutritional value (FAO, 1988; Ahmed and Abozed, 2015). It is a good source of vitamins, minerals, protein, anthocyanin, dietary fiber, ascorbic acid, hibiscus acid and bioactive compounds such as organic acids, phytosterols and polyphenols and has a good antioxidant properties (Abdel-Moemin, 2016; Arpita *et al*., 2017). It has lots of medicinal as well as commercial importance. Medicinal uses include its uses as antioxidant, anti-cancerous, antihypertensive and antimicrobial. It can also be used for curing anemia, diuretic and good for healthy bone and teeth formation. Commercially it can be used for the production of natural food color (Abouarab-Azza *et al*., 2011; Mohamed *et al*., 2012; Arpita *et al*., 2017). Roselle is native from India to Malaysia, where it is commonly cultivated, and must have been carried at an early date to Africa (Da-Costa-Rocha *et al.,* 2014). Roselle is now cultivated in many tropical and subtropical regions of the world (Khalid *et al*., 2012; Gebremedin and Asfaw, 2017). Calyces of Roselle contain nine times more vitamin C than citrus (Mgaya *et al*., 2014; Ogundele *et al*., 2016).

Pumpkin (*Cucurbita moschata*) is an important source of dietary fiber, vitamins, carotenoids, ascorbic acid, polysaccharides, mineral compounds (K, Ca, Mg and Fe), starch, and pectin (Li, 2008; Kulaitiene *et al.,* 2014). Beta-carotene in plants that have a pleasant yellow-orange color is a major source of vitamin A (Lee, 1983; DeCarvalho *et al*., 2012). Consumption of foods containing carotene helps prevent skin diseases, eye disorders and cancer (Bendich, 1989; Faustino *et al*., 2016). It also contains other substances beneficial to health such as phenolic phytochemicals (Kwon *et al*., 2007; Dhiman *et al*., 2009; Amin *et al*., 2018).

Maize (*Zea mays*) is an important staple food in many countries of the world. The maize germ, which accounts for 5-14% of the weight of a maize kernel, depending on variety and grain size, is high in protein content, dietary fiber and minerals (Barbieri and Casiraghi, 1983; Naves *et al*., 2011) and are balanced in most of the essential amino acids; (Gupta and Eggum, 1998; Naves *et al*., 2011).

Rice bran (*Oryza sativa* L.) is the outer covering of rice kernel and consists of pericarp, aleurone, subaluerone layer, seed coat, nucellus, part of the germ and small part of starchy endosperm (Salunkhe *et al*., 1992; Hargrove, 1994; Raghav *et al*., 2016**)**. It is a by-product of rice milling industry and constitutes around 10% of the total weight of rough rice. Rice bran is a rich source of vitamins, minerals, essential fatty acids, dietary fiber and other sterols. Antioxidant compounds such as polyphenols, carotenoids, vitamin-E, gamma oryzanol, and tocotrienol which helps in preventing the oxidative damage of body tissues and DNA (Ling *et al*., 2002; Law *et al*., 2017; Tan and Norhaizan, 2017). Rice bran protein is a good source of well-balanced amino acid (Rohrer and Siebenmorgen, 2004; Phongthai *et al*., 2017). Rice is the most common staple food which is consumed by half of the World's human population. It is the third highest agricultural commodity with the worldwide production of sugarcane and maize (FAO-STAT, 2012).

Biscuit is most popular bakery product worldwide, with high in carbohydrates, fat and calorie but low in fiber, vitamin, and mineral which make it unhealthy for daily use. Because of its acceptability in all age group, longer shelf life, better taste and its position as snacks it is considered as a good product for protein fortification and other nutritional improvement (Serrem *et al*., 2011; Saini *et al*., 2017; Kumar *et al*., 2018). Therefore, this study was a trial to develop a suitable high nutrition values product(biscuit) for feeding school children by using different highly nutritional value sources (*i.e.* Pumpkin, yellow corn germ, white kidney bean, rice bran and roselle flower). The resultant biscuit was organoleptically, chemically, physically and microbiologically evaluated.

MATERIALS AND METHODS

Materials:

The current study was performed at, Food Tech. Res. Institute. Bread and Pastries Technology Research laboratory, Agric. Res. Center, Giza, Egypt, during two successive seasons (2015 and 2016).

-Wheat flour 72% extraction rate (*Triticum aestivum* L.) was obtained from Elfagr-wadi el melouk co. for milling, Egypt.

-Pumpkin (*Cucurbita moschata*) was obtained from Horticultural Research Institute, Agricultural Research Center, Doki, Giza, Egypt.

-Yellow corn germ (*Zea mays*) was obtained from Almasria to Starch and Glucose **-** Company- Mostorod, Egypt.

-White kidney bean (*Phaseolus vulgaris* L.) was obtained from Alsuhagy for Food Industries, Elkanater Elkhairia, Egypt.

-Stabilization rice bran was obtained from the experimental farm of Rice Mechanization Center (RM), Sakha, Egypt.

-Roselle calyxes and floral bracts (*Hibiscus sabdriffa* L.) were obtained from Medical and Aromatic Plants Research Dep., Agricultural Researches Center, Giza, Egypt.

-Chemicals used in this study were purchased from El-Gomhoria and El Shark El Aost Companies, Egypt.

Methods:-

Preparation of Pumpkin Flour:

Pumpkin fruits were washed and peeled, fibrous matter and seeds were removed and the flesh was cuts into small pieces. The pumpkin pieces were then cut into slices of 2-3 mm thickness sheared using a slicer and dried in a ventilated oven at 150°C /20 min to inhibit the oxidative and pectin enzymes, increase the evaporated water and decrease the microbial load. The slices were dried in a ventilated oven at 60°C until complete dryness. The dried pumpkin slices were grounded by using a mixer (MIENTA super blender, Model BL -721). Then the flour was sieved to pass through a 300 mesh siever. The resultant sieved flour was then kept in an airtight container and stored in a chiller prior to use (See *et al*., 2007).

Preparation of yellow corn germ flour:

The yellow corn germ was grounded by using a mixer{(MIENTA super blender) (Model BL -721)}. Then sieved using 100 mesh siever and the obtained flour was finally packaged in sealed polyethylene bags due to the hygroscopic nature of the flour until used for blending and analysis.

Preparation of Kidney bean flour:

The kidney bean flour was prepared according to the method described by Giami and Bekebain (1992). One kilogram of kidney bean seeds which was free from dirty and other foreign materials such as stones, sticks. Seeds were ground by using mixer (MIENTA super blender, Model BL -721) and dried in the cabinet dryer (120°C/90 min). During drying, the ground seeds were stirred at intervals of 30 minutes to ensure uniform drying. The ground seeds were sieved to pass through a 300 mesh sieve. The milled seeds kidney bean flour, placed in an aluminum paper. The obtained flour was finally packaged in sealed polyethylene bags due to the hygroscopic nature of the flour until used for blending and analysis.

Preparation of heat stabilization rice bran Flour:

Heat Stabilization Rice bran (HRB) was sieved to pass through a 300 mesh sieve. And the fine rice bran powder was used in further experiments. The obtained flour was finally packaged in sealed polyethylene bags due to the hygroscopic nature of the flour until used for blending and analysis.

Preparation of Roselle powder (Kujurat):

Kerkrade calyx and floral bracts were prepared according to the method described by **Cid-Ortega and Guerrero (2014)** through ground by using a mixer (MIENTA super blender)(Model BL -721). The milled calyxes and floral bracts, were sieved to pass through a 300 mesh sieve, and finally packaged in sealed polyethylene bags due to the hygroscopic nature of the flour until used for blending and analysis.

Preparation of biscuits:

The biscuits were prepared in the lab of Bread and Pastries Research Dept., Food Technology Institute. Agric. Research Center. Ingredients used to make biscuits were given in Table (1). Biscuits were made according to the method described by **Wade (1988)** with some modification.

Table (1): The formula used for preparing sweet biscuits

Ingredients	Amount
Wheat flour (72% ex.) (g)	100
Egg (g)	24
Sugar (g)	30
Butter (g)	22
Baking powder (g)	1.5
Vanillin (g)	1

Treatments:

Pretest experiment has been carried out to determine the best mix ratio of suggested raw materials which were chosen for this study as shown in the following Table (2).

Table (2): The suggested blends used for preparing sweet biscuits

Treat.		Blends composition	G3*
Control		Wheat flour 72% extraction rate (soft)	
Duple mixes	**1**	80% wheat flour +14% corn germ + 6% kujurat powder	GK
	2	80% wheat flour +10% corn germ +10% rice bran flour	GR
	3	80% wheat flour +10% pumpkin pulp powder +10% corn germ	PG
	4	80% wheat flour +14% pumpkin pulp powder +6% kujurat powder	PK
	5	80% wheat flour +10% pumpkin pulp powder +10% rice bran flour	PR
	6	80% wheat flour + 10% pumpkin pulp powder +10% white kidney bean powder	PWb
	7	80% wheat flour +14% rice bran flour +6% kujurat powder	RK
	8	80% wheat flour +10% white kidney bean powder +10% corn germ	WbG
	9	80% wheat flour +14% white kidney bean powder +6% kujurat powder	WbK
	10	80% wheat flour +10% white kidney bean powder +10% rice bran flour	WbR
Multi mixes	**11**	75% wheat flour +5% white kidney bean powder +5% corn germ + 5% rice bran +5% kujurat powder +5% pumpkin pulp powder	T1
	12	75% wheat flour +10% white kidney bean powder +5% corn germ +5% rice bran flour +3% pumpkin pulp powder +2% kujurat powder	T2
	13	75% wheat flour +10% rice bran flour +5% white kidney bean powder +5% corn germ +3% pumpkin pulp powder +2% kujurat powder)	T3
	14	75% wheat flour +10% corn germ +5% white kidney bean powder +5% rice bran flour +3% pumpkin pulp powder +2% kujurat powder)	T4

Preparation of sweet biscuits in the laboratory:

For making biscuit: sugar and butter were creamed by using a mixing machine for 1 min. Eggs were beaten by whip and vanilla was added to the beaten eggs. Sugar- butter creamed was added to egg-vanilla mixture and well beaten at low speed for 5 min., dry ingredients (wheat flour or its blends and baking powder) were stirred together and added to the mixture gradually followed by beaten continuously until the blend became smooth, and the resulted dough was left to rest for 15 min. The dough was rolled in a cookie sheet using a guide roll. The dough was cut in circles (5 cm diameter and 0.3 cm thick), and the transferred to greased plate, then the baking process was carried out in an electrically heater oven at170°C for 12-15 min. After baking, biscuits were allowed to cool at room temperature for 1hr before sensory evaluation (AACC, 2010).

Sensory characteristics estimation of experimental baked sweet biscuits:

A preliminary study was carried out for determination of the sensorial acceptable level of the mixed for investigated raw materials. The sensory characteristics of biscuits were evaluated according to the method of Manohar and Rao (1997) and were carried out by a panel of ten experienced judges from the staff of the Food Technol. Res. Institute, Agric. Res. Center, Giza, Egypt. Assigning scores for various quality attributes such as: color (20), texture (20), taste (20), crust appearance (20), odor (20), and overall acceptability (100) (San José *et al.,* 2018).

Packaging and Storage of produced biscuits:

After identification of the best sensorial acceptable mixed level of the investigated raw material, the best treatment of biscuit was prepared as mentioned previously. After baking, biscuits were allowed to cool at the room temperature for 1hr then packaging as following: -Six pieces of biscuits (4-5g/each) were packed in transparence poly propylene packages (20/20 microns) in Food Engineering and Packaging Department Agricultural Research Center to evaluation the products quality during storage time for 180 days at room temperature (20-25°C). Also, resultant biscuits were chemically and physically evaluation after baking.

Chemical analysis:

-Moisture, protein, ash, crude fat, crude fiber content, peroxide value and acid value were determined according to the method described in AOAC (2012).

-Available carbohydrates content of the sample was calculated by the difference as mentioned by Fraser and Holumes (1959).

% Available carbohydrates (on dry basis) = 100 – (%Ash + %Fat +%Protein + %Fiber).

-The approximate energy of biscuits was calculated according to the (FAO/WHO, 1974) as follows:-

Total energy (K.cal/100g) = 4(%carbohydrate +% protein) +9 (%fat)

- Minerals content, i.e., Fe, Zn, Ca, Mn and Mg were determined by Atomic Absorption Spectrophotometer (3300 Perkin-Elmer) as described in AOAC (2012).

- Vitamin content: vitamin A, E, D and K were determined according to the methods described by Plozza *et al* (2012). Vitamin B group (B1, B2, B3, B6, B9and B12) were determined according to the methods described by Batifoulier *et al*. (2005).

- Amino acids were determined according to the method described in AOAC (2012) by using high-performance Amino Acids Analyzer (Biochroom 30).

- Protein Efficiency Ratio (PER) was estimated using the equation reported by Alsmeyer *et al* (1974) as follows:-

$$PER= 0.684 +0.456\ (leucine) - 0.047\ (proline)$$

- Biological value (BV) was estimated using the equation suggested by Mitchel and Block (1946) as follows:-

$$B.V= 49.9 + 10.53PER$$

- Fatty acids were determined according to the method described in IUPAC (2000).

- Water activity (a_w) was measured at 25°C by using a Decagon A qualab Meter Series 3TE (Pullman, WA, USA). All samples were broken into small pieces immediately before water activity measurement.

Physical properties:

According to Manohar and Rao (1997), the diameter (D) and thickness (T) of five biscuits were measured in millimeter by placing them the edge to edge and by stacking one above the other, respectively. To obtain the average, measurements were carried out by rearranging and restocking. Spread ratio was calculated by dividing the diameter of the biscuit (mm) by their thickness (mm). The weight of five biscuits was determined after cooling. The volume was measured by displacement of rape seed. Specific volume was calculated by dividing volume (cm^3) by biscuit weight (g). A spread factor was calculated by mathematically divided spread ratio of the sample on spread ratio of control.

$$Spread\ ratio = \frac{Diameter}{Thicness}$$

$$Spread\ factor = \frac{Spread\ ratio\ of\ sample}{Spread\ ratio\ of\ control}$$

Texture Profile Analysis.

A texture analyzer (BROOKFIELD CT3 TEXTURE ANALYZER Operating Instructions Manual No. M08-372-C0113, Stable Micro Systems, USA) was used to measure the texture profile of sweet biscuits in terms of hardness (N) of the samples. Test Type: Compression, Target=5.0mm, Hold Time=0s, Trigger Load: 5.00 N (Newton), Test Speed= 2.00mm/s, Return Speed= 2mm/s, of Cycles: 1.0, Pretest Speed: 2 mm/s, Probe: TA-PFS-C, Fixture: TA-RT-KIT, Load Cell: 10000g.The experiments were conducted under ambient conditions.

Color measurements of biscuits.

External color of the products was measured according to the method outlined by Mc Gurie (1992) using a handheld Chromameter (Model CR-400, Konica

Minolta, Japan). The apparatus provided L^* (lightness with L = 100 for lightness, and L = zero for darkness), a^*[(chromaticity on green (−) to red (+)], b^* [(chromaticity on a blue (−) to yellow (+)], c^* (color saturation), h^o [(hue angle were 0˚ = red to purple, 90˚ = yellow, 180˚ = bluish to green and 270˚ = blue] scale.

Microbiological analysis.

Total bacterial, Yeast, and molds count were determined according to the procedure described by Harrigan and McCance (1978).

Statistical analysis:

The data were obtained from sensory evaluations, chemical composition and physical properties were performed in triplicate for each sample by the least significant difference value (LSD) at 0.05 level probability procedure to analyze using statistical software SAS (1985).

RESULTS AND DISCUSSION

The chemical composition of the used raw materials:

The chemical composition of raw materials under investigation were found in the Table (3). It could be noticed that wheat flour (72% ex.) contained the highest value of available carbohydrate (87.61%) whereas it showed the lowest values of crude fat, ash and crude fiber (0.98, 0.63 and 0.59 %, respectively). Wet milling corn germ contained the highest values of crude fat, crude fiber and energy (53.79%, 18.48% and 591.27 Kcal/100g, respectively). While White kidney bean contained the highest value of protein (25.69 %) followed byheat stabilizations rice bran (14.85%). Roselle calxes contained the highest value of ash (11.09%). These results were nearly with that found by Bala *et al.* (2015), Goma-maha (2012), EL-Nagar (2005), El-Syiad and Hassan, (2014), Raghav *et al.* (2016) and Khalil *et al.* (2012).

Table (3): Chemical composition (%) and minerals content (mg/100g) of raw materials which used for the preparation of biscuit types (on dry weight bases)

Composition (%)	Wheat flour (72% ex.)	Pumpkin Pulp	Wet milling corn germ	White Kidney bean	Heat stabilizations rice bran	Roselle calxes
Moisture	12.92[a] ±0.09	10.12[c] ±0.06	2.10[e] ±0.34	2.01[e] ±0.12	6.93[d] ±0.02	11.35[b] ±0.01
Protein	10.19[d] ±0.16	7.18[e] ±0.80	11.97[c] ±0.21	25.69[a] ±0.09	14.85[b] ±0.09	10.65[d] ±0.13
Crude fat	0.98[f] ±0.15	2.18[d] ±0.12	53.79[a] ±0.22	6.81[c] ±0.05	16.79[b] ±0.06	1.73[e] ±0.20
Ash	0.63[e] ±0.08	7.20[b] ±0.03	0.94[e] ±0.01	3.21[d] ±0.40	6.04[c] ±0.26	11.09[a] ±0.01
Crude fiber	0.59[f] ±0.01	8.55[d] ±0.21	18.48[a] ±0.50	3.39[e] ±0.06	9.34[c] ±0.23	14.97[b] ±0.47
Available carbohydrate	87.61[a] ±0.10	74.89[b] ±0.92	14.82[e] ±0.94	60.90[c] ±0.60	52.98[d] ±0.18	61.56[c] ±0.55
Energy K.cal/100g	400.02[d] ±1.07	347.90[e] ±1.54	591.27[a] ±0.94	407.65[c] ±1.57	422.43[b] ±0.16	304.41[f] ±0.93
Mineral mg/100g						
Fe	1.81[d] ±0.01	5.63[c] ±0.135	4.42[cd] ±0.14	6.61[c] ±0.05	28.20[a] ±1.82	13.70[b] ±0.50
Zn	1.15 [d] ±0.04	4.89[bc] ±0.26	11.14[a] ±0.59	5.47[b] ±2.08	5.61[b] ±0.83	3.33[c] ±0.01
Ca	20.67[f] ±1.15	91.71[c] ±0.55	22.72[ef] ±0.31	302.94[a] ±12.60	41.88[d] ±4.03	153.59[b] ±5.92
Mn	0.65[cd] ±0.08	0.26[e] ±0.01	0.42[de] ±0.04	0.75[c] ±0.02	5. 10[a] ±0.08	4.09[b] ±0.31
Mg	18.61[e] ±0.08	59. 30[d] ±1.10	21.30[e] ±4.20	66.53[c] ±4.80	75.70[b] ±2.50	83.33[a] ±0.45

Values are mean ±SD.
Each value with the same row followed by the same letters is not significantly different at level of 0.05.

Minerals content of the used raw material:

Minerals content of raw materials constitute a very important food mixtures calcium, iron, magnesium and zinc are the most important for physiological requirements of children. For example calcium is combined as the salts give hardness to bones and teeth, iron is required for an expanding blood volume and increasing amounts of hemoglobin in grown children, magnesium is essential for all living cell, it is a catalyst in numerous metabolic reaction and zinc as an integral part of least 20 enzymes that belong to a large group known as metabloenzymes (Beard, 2001; Hotez and Brown, 2004 and Soetan *et al*., 2010).

The data presented in Table (3), demonstrated that wet milling corn germ had the highest value of Zn (11.14 mg/100g). White kidney bean had the highest value of Ca (302.94 mg/100g). Heat Stabilizations rice bran had the highest values for Fe (28.20 mg/100g) and Mn (5.10mg/100g). Rosella calxes had the highest value of Mg (83.33mg/100g). While soft wheat flour (72% extraction) had the lowest value in these previous minerals (1.81, 1.15, 20.67, 0.65 and 18.61 mg/100gfor Fe, Zn, Ca, Mn and Mg, respectively). These results were nearly with that found by Ahmed and Abozed (2015) for Rosella calxes and Naves *et al.* (2011) for corn germ.

Also, from the present data, it is clearly noticed that combination of soft wheat flour (72% extraction) with raw materials under investigation as a flour supplemented caused an increase in minerals content in mixed flour.

Sensory evaluation of preliminary blends of sweet biscuits:

Sensory evaluation is considered as an important indicator of potential consumer preferences, In spite of its shortcomings, it will remain one of the most reliable quality assessment technique for food and food products in general and for bread and bakery products in particular (Stone, 2012). So that pretest experiment has been carried out to determine the best mixes ratios of suggested raw materials and selected for this study. Overall acceptability of produce sweet biscuits as a result of the effect of all sensory characteristics, evaluated as "90-100 degrees was very good" in comparison to "Less than 70 degrees was questionable". The sensory evaluation of double mixes from suggested raw materials, Table (4) showed that samples PG, PR, PWb, WbG and WbR had a slight significant difference compared with control biscuit, and still had very good acceptable scores. With respect to produce sweet biscuits strengthening with formulated of mixes additives, Table (5) showed that sample T3 were not significantly differenced compared with control biscuit, and had a very good acceptable scores. So these previous levels which obtained very good acceptability could be selected for evaluation in this study. These results are in good agreement with those reported by Afify–Haiat (2012) and Shahine-Fatma *et al.* (2013).

Table (4): Sensory evaluation of biscuits supplemented with double of additives

Biscuit's samples	General appearance (20)	Odor (20)	Taste (20	Crispy (20)	Color (20)	Total score (100)	Acceptance
100% W (Con.)	19.60^{a} ± 0.70	19.40^{a} ± 0.70	19.45^{a} ±0.69	19.40^{a} ±0.52	19.40^{a} ±0.82	97.15^{a} ±3.04	**V**
80%W+14%G+6%K (GK)	17.40^{cd} ±1.08	16.50^{ef} ±1.90	16.60^{c} ±1.78	16.45^{c} ± 2.06	17.25^{c} ± 1.32	84.20^{d} ±6.05	**G**
80%W +10%G+10%R (GR)	17.60^{cd} ±1.51	17.20^{edf} ±1.93	17.00^{bc} ±2.06	17.20^{bc} ±2.35	17.90^{bc} ±1.73	86.90c^{d} ±8.37	**G**
80%W +10%P+10%G (PG)	19.30^{a} ±0.68	18.90^{a} ±0.74	17.75^{bc} ±1.28	17.80^{b} ±1.49	19.25^{a} ±0.64	93.00^{ab} ± 3.21	**V**
80%W +14%P+6%K (PK)	18.00^{bcd} ±1.25	17.60^{bcde} ±1.08	17.00^{bc} ±1.56	17.35^{bc} ±1.38	17.50^{c} ±1.38	87.45^{cd} ±4.43	**G**
80%W +10%P+10%R (PR)	18.90^{ab} ± 0.88	18.60^{ab} ± 0.97	17.40^{bc} ±1.17	17.50^{bc} ± 1.67	18.90^{ab} ±0.99	91.30^{bc} ± 4.39	**V**
80%W+10% P +10%Wb (PWb)	19.40^{a} ±0.52	19.00^{a} ±0.67	18.20^{ab} ±1.23	18.05^{b} ±1.12	19.25^{a} ±0.72	93.90^{ab} ±2.86	**V**
80%W +14%R+6%K (RK)	17.10^{d} ±1.97	16.10^{f} ±2.42	16.90^{bc} ±2.18	17.10^{bc} ±1.52	17.20^{c} ±1.62	84.40^{d} ±8.71	**G**
80%W +10%Wb+10%G (WbG)	18.75^{ab} ±0.98	18.50^{abc} ±1.27	18.20^{ab} ±0.92	18.05^{b} ±0.83	19.05^{a} ±0.83	92.55^{ab} ±3.98	**V**
80%W +14%Wb+6%K (WbK)	17.40^{cd} ±1.58	17.30^{cdef} ±1.25	17.35^{bc} ± 1.92	17.10^{bc} ±1.91	17.10^{c} ± 1.60	86.25^{d} ± 5.12	**G**
80%W+10%Wb+10%R (WbR)	18.20^{bc} ±1.14	18.20^{abcd} ± 0.92	18.00^{b} ±0.82	18.40^{ab} ±0.70	18.60^{ab} ± 0.84	91.40^{bc} ±3.27	**V**

Values are mean ±SD.
Each value with the same column followed by the same letters is not significantly different at level of 0.05 90-100 very good (V) 80-89 Good (G) 70-79 Satisfactory (S) Less than 70 questionable (Q)
W = wheat flour P = Pumpkin G= Yellow corn germ R= Stabilization rice bran K= kjurat (Rosall calxes)
Wb= White Kidney bean as according to the Table (2).

Table (5): Sensory evaluation of biscuits supplemented with multi additives

Biscuit's samples	General appearance (20)	Odor (20)	Taste (20	Crispy (20)	Color (20)	Total score (100)	Acceptance
Con (100% W)	19.20[a] ±0.92	19.20[a] ±0.92	18.90[a] ±1.45	18.80[a] ±1.45	19.00[a] ±1.33	95.10[a] ±5.80	**V**
T1 (75%W+5%Wb+5%G +5%R+5%K+5%P)	17.20[c] ±1.03	18.20[a] ±1.398	17.60[b] ±1.08	17.90[a] ±1.29	16.60[b] ±0.70	87.50[b] ±3.81	**G**
T2 (75%W+10%Wb+5%G +5%R+3%P+2%K)	17.50[bc] ±0.85	18.30[a] ±1.34	17.9[ab] 1±.52	17.50[a] ±2.07	16.60[b] ±1.07	87.80[b] ±5.94	**G**
T3 (75%W+10%R+5%Wb +5%G+3%P+2%K)	18.20[b] ±0.79	18.40[a] ±1.43	18.10[ab] ±1.10	18.30[a] ±1.10	17.40[b] ±1.17	90.40[ab] ±4.74	V
T4 (75%W+10%G+5%Wb +5%R+3%p+2%K	17.70[bc] ±1.06	18.10[a] 1±.52	17.75[ab] ±1.88	17.60[a] ±1.78	17.10[b] ±1.20	88.25[b] ±6.63	**G**

Values are mean ±SD.
Each value with the same column followed by the same letters is not significantly different at level of 0.05
90-100 very good (V). 80-89 Good (G). 70-79 Satisfactory (S). Less than 70 questionable (Q).
W = wheat flour P = Pumpkin G= Yellow corn germ R= Stabilization rice bran K= kjurat
Wb= White bean as according to the table (1).

Chemical composition of resultant biscuits:

An adequate knowledge of the chemical composition of food is vital to the health, well-being and safety of the consumer (Jansen van Rijssen *et al*., 2013; Toomer, 2017).

The chemical changes in selected sweet biscuits as influenced by supplementation of different suggested raw material were studied and the obtained results are shown in the Table (6). The protein content ranged between 8.12% in the PG Sample and 8.98% for the PWb sample compared with 7.60% for the control. As to the fat content ranged between 15.03% in PWb sample and 17.96% for WbG sample compared with 13.63% for control. The determination of ash content reveals information relating to minerals. In the present study, there was no significant difference in ash content for supplemented samples, the values of ash content varied between 1.82% in sample WbG and 2.26% for PR sample compared with 1.06 % for control. The crude fiber content of the different samples was found to vary between 0.30% in T3 sample and 1.88% for PG sample compared with 0.30% for control. Regarding the available carbohydrates content, it was observed that the values varied from 69.97% in WbG sample and 72.93% in PWb sample compared with 76.87% for control. The energy values varied from 464.51 Kcal/100g in sample PR and 478.13 Kcal/100g in T3sample compared with 460.55 Kcal/100g for control. These results are due to the different nutritional values of raw materials used. These results are in agreement with the results given by Mishral and Chandra (2012), Afifi-Haiat (2012) and Abdel-Moemin (2016), Gomaa-Maha (2012) and Shahine-Fatma (2013).

Minerals content of biscuit:

Also, from the results presented in the Table (6), it could be demonstrated that WbR sample had the highest values of Fe, Mn and Mg (3.31, 0.84 and 19.08 mg/100g, respectively.). The highest value of Zn was observed in T3 sample (1.51 mg/100g). While the highest value of Ca was obtained in sample PWb (31.08 mg/100gm). On the other hand control sample contained the lowest value for Fe, Zn, Ca, Mn and Mg (1.50, 0.72, 0.37 and11.56 mg/100g, respectively. These results are in a good agreement with those reported by EL-Nagar (2005), Gomaa-Maha (2012), Shahine-Fatma *et al.* (2013), Ahmed and Abozed (2015), and Younas *et al.* (2011).

Vitamins content of biscuit:

The data outlined in Table (7) showed that, all samples of supplemented biscuit had an increasing values of vitamins contents i.e., A, E, K, Thiamine (B1), Riboflavin (B2), Nicotinic acid (B3), Pyridoxin (B6) and Folic Acid (B9) compared with control (unsupplemented biscuit). Hence, supplemented biscuits are favorable than control (unsupplemented biscuit) because of their high content of important vitamins. These data are agreed with findings of Gomaa-Maha (2012) and Shahine-Fatma *et al*. (2013) and Raghav *et al*. (2016) and Anel *et al*. (2016).

Amino acids content of supplemented biscuit:

Protein quality is partly dependent upon its amino acid profile. The non-essential amino acids are those the body can synthesize and therefore non-essential in the diet. The essential amino acids, on the other hand are very important from the nutritional point of view since the body cannot make and should, therefore, be supplemented in the diet (Mohammed *et al.,* 2016). The quality of the protein in the biscuits was investigated in terms of the essential amino acid content and PER and BV, which is a method of evaluating the protein quality. The data in Table (8) showed that, all samples of supplemented biscuits had the highest quantity of

Leucine, Threonine, and Valine and total essential amino acids (total EAA) and other amino acids such as arginine and aspartic, compared to those in control biscuits. However, proline and total non-essential amino acids (total NEAA) were higher in control biscuits than in supplemented biscuits.

The protein efficiency ratio (PER) and biological value (BV) of all supplemented biscuits were higher than that for control biscuits. And WbR sample had the highest value of total EAA, PER, and BV than control biscuits and other produced supplemented biscuits.

Table (6): Chemical composition (%) and minerals content (mg/100g) of selected biscuits (on dry weight bases)

Composition (%)	Biscuit's samples						
	Con	**PWb**	**PG**	**PR**	**WbG**	**WbR**	**T3**
Protein	7.60[b] ±0.79	8.98[a] ±0.14	8.12[ab] ±0.21	8.47[ab] ±0.10	8.67[a] ±0.58	8.85[a] ±0.89	8.78[a] ±0.46
Fat	13.63[d] ±1.29	15.03[c] ±0.18	17.05[ab] ±1.33	15.75[bc] ±0.15	17.96[a] ±0.61	15.86[bc] ±0.24	17.64[a] ±0.07
Ash	1.06[b] ±0.50	2.11[a] ±0.53	1.95[a] ±0.53	2.26[a] ±0.56	1.82[ab] ±0.41	2.08[a] ±0.49	2.22[a] ±0.53
Crude fiber	0.30[e] ±0.03	0.95[d] ±0.07	1.88[a] ±0.15	1.30[c] ±0.10	1.58[b] ±0.13	1.00[d] ±0.09	0.30[e] ±0.03
Available Carbohydrate	76.87[a] ±2.59	72.93[b] ±0.64	71.00[bc] ±2.21	72.22[bc] ±0.89	69.97[c] ±1.73	72.21[bc] ±1.71	71.07[bc] ±1.08
Energy Kcal/100g	460.55[d] ±4.35	473.85[cd] ±1.51	469.93[b] ±3.93	464.51[cd] ±1.88	476.20[a] ±0.89	466.98[bc] ±1.10	478.13[a] ±1.88
Minerals content (mg/100g)							
Fe	1.50[c] ±0.48	2.30[b] ±0.12	2.21[b] ±0.06	3.17[a] ±0.36	2.25[b] ±0.34	3.31[a] ±0.31	3.01[a] ±0.58
Zn	0.72[e] ±0.09	1.16[d] ±0.14	1.45[ab] ±0.12	1. 27[cd] ±0.03	1.31[bc] ±0.00	1.39[abc] ±0.02	1.51[a] ±0.04
Ca	13.22[b] ±0.85	31.08[a] ±10.47	18.30[b] ±7.29	19.15[b] ±7.78	23.28[ab] ±13.79	23.85[ab] ±14.56	23.91[ab] ±9.66
Mn	0.37[cd] ±0.01	0.50[b] ±0.01	0.28[d] ±0.01	0.57[b] ±0.19	0.49[bc] ±0.02	0.84[a] ±0.04	0.82[a] ±0.02
Mg	11.56[c] ±1.35	17.80[a] ±0.50	14.37[b] ±1.15	17.87[a] ±0.65	15.41[b] ±0.30	19.08[a] ±0.10	17.77[a] ±0.95

Values are mean ±SD.
Each value with the same row is followed by the same letters is not significantly different at the level of 0.05.

Table (7): Vitamins contain of biscuits made from mixed blends (% on dry weight basis).

Vitamins	Biscuit's samples						
	Con.	**PWb**	**PG**	**PR**	**WbG**	**WbR**	**T3**
V.A (µg/100g)	120.65	147.57	146.80	145.98	121.48	120.77	128.29
V. E (mg/100g)	0.236	0.320	0.764	0.600	0.711	0.587	0.804
V.K (µg/100g)	0.176	1.330	0.204	0.312	1.242	1.351	0.759
V.B1 (Thiamine) (mg/100g)	0.07	0.09	0.10	0.22	0.13	0.25	0.24
V. B2 (Riboflavin) (mg/100g)	0.022	0.036	0.047	0.033	0.054	0.047	0.037
Nicotinic acid B3 (mg/100g)	0.72	0.74	0.86	2.59	0.95	2.67	2.71
V.B6 (pyridoxine) (mg/100g)	0.024	0.041	0.018	0.260	0.041	0.280	0.263
V.B9 (Folic Acid) (µg/100g)	15.09	36.35	15.27	16.67	36.24	38.54	17.19
V.B 12 (Cyanocobalamin) (µg/100g)	0.00	0.003	0.003	0.003	0.00	0.00	0.001

Table (8): Amino Acids composition (g A.A/100g protein) of selected biscuits (% on dry weight basis)

Amino Acids	Biscuit's samples							FAO/WHO Pattern (1991)	
	Con	PWb	PG	PR	WbG	WbR	T3		
	Essential Amino Acids (EAA)							Child	Adult
Histidine	3.15	3.21	3.18	2.93	3.07	4.18	2. 88	1.9	1.6
Lysine	3.41	3.57	2.64	2.79	4.17	4.29	3.47	5.8	1.6
Isoleucine	4.46	4.53	4.37	4.20	4.28	4.52	4.36	2.8	1.3
Leucine	7.60	7.75	7.69	7.63	7.69	7.80	7.70	6.6	1.9
Methionine	2.09	1.66	1.72	1.78	1.75	1.81	2.23		
Cysteine	2.35	1.91	1.98	2.54	1.86	1.69	1.11		
Methionine+Cysteine	4.44	3.57	3.70	4.32	3.61	3.50	3.34	2.5	1.7
Phenylalanine	5.13	5.95	5.83	5.86	5.93	6.10	5.21		
Tyrosine	4.20	4.29	4.78	4.45	4.28	4.18	3.83		
Phenylalanine+ Tyrosine	9.33	10.24	10.61	10.31	10.21	10.28	9.04	6.3	1.9
Threonine	3.01	3.33	3.18	3.13	3.39	3.61	3.91	3.4	0.9
Valine	4.50	5.48	5.44	5.47	5.37	5.43	5.46	3.5	1.3
Tryptophan	-	-	-	-	-	-	-	1.1	0.5
Total (without histidine)	36.75	38.47	37.63	37.85	38.72	39.43	37.28	32.0	11.1
Total EAA	39.90	41.48	40.81	40.78	41.79	43.61	40.16	33.9	12.7
Non-Essential Amino Acids (NEAA)									
Arginine	4.59	5.12	4.91	4.96	5.27	5.76	5.09		
Aspartic acid	5.78	7.38	6.36	6.62	7.03	7.57	7.02		
Serine	4.20	4.76	4.78	3.81	5.15	5.53	6.09		
Glutamic acid	23.29	22.44	22.56	23.57	21.97	18.55	22.79		
Proline	11.11	8.34	9.28	8.66	8.12	8.14	7.92		
Glycine	3.93	3.81	3.97	3.97	3.84	3.85	3.75		
Alanine	4.32	4.29	4.50	5.09	4.28	4.40	4.58		
Total NEAA	57.22	56.14	56.36	56.68	55.66	53.80	57.14		
Total AA	97.12	97.62	97.17	97.46	97.45	97.41	97.30		
PER	3.62	3.83	3.75	3.75	3.80	3.85	3.82		
BV	88.01	90.22	89.39	89.38	89.91	90.44	90.12		

*Tryptophan was not determined.

From aforementioned data recorded in Table (8), it could be also observed that all essential amino acids of control and other produced supplemented biscuits had values higher than those of pattern recommended by FAO/WHO (1991) for adults, and also for the child except for lysine and Threonine for most samples.

These results were in agreement with those of Madsen (2008) who mentioned that protein of rice bran is appraised as a high-grade protein due to the variation of amino acids and types of protein in the crude extract. In addition combinations of legumes and cereals provide better overall essential amino acid balance (Boye *et al*., 2010).

Fatty acids content of supplemented biscuit:

Fatty acids composition of resultant biscuits are given in Table (9). From the obtained results, it could be observed that Palmitic acid was the major saturated fatty acid (SFA) compared with other SFA in all samples of biscuits. While oleic acid and linoleic acid were the major unsaturated fatty acid (UFA) compared with other UFA. All samples of supplemented biscuits had the highest value of UFA and lowest value of SFA compared with control sample. The highest total unsaturated fatty acids contents (46.29%) are given in sample PG followed by WbR (45.64%) then PWb (45.35%).

A low intake of saturated fat and an increased unsaturated to saturated fatty acid ratio are associated with a low risk of human coronary heart disease (Hu *et al*., 1997; 1999).

Table (9): Fatty acids composition (% oils of the sample) extracted from supplemented biscuits

Fatty Acids	Biscuit's samples						
	Con.	**PWb**	**PG**	**PR**	**WbG**	**WbR**	**T3**
Saturated Fatty Acids (SFA)							
C4:0 Butyric acid	1.46	0.23	0.16	1.12	0.64	1.11	0.68
C6:0 Caproic acid	1.66	0.49	1.16	1.35	1.45	1.28	1.44
C8:0 Caprylic acid	1.10	0.41	0.81	0.90	0.99	0.85	0.97
C10:0 Capric acid	2.57	1.24	1.94	2.19	2.37	2.01	2.24
C11:0 Undeconic acid	-	-	0.08	0.08	0.06	0.06	-
C12:0 Lauric acid	4.01	2.79	3.49	3.95	4.15	3.47	2.64
C13:0 Brassylic acid	0.07	0.06	0.26	0.27	0.25	0.19	0.06
C14:0 Myristic acid	9.80	8.32	8.07	9.38	9.60	8.17	8.60
C15:0 Pentadecanoic acid	0.83	0.92	0.77	0.96	0.26	0.78	0.72
C16:0 Palmitic acid	**29.34**	26.67	24.19	26.17	26.22	24.01	27.80
C17:0 Margaric acid	0.77	0.68	0.51	0.70	0.58	0.52	0.51
C18:0 Stearic acid	9.92	8.96	7.66	8.69	8.42	7.65	8.91
C20:0 Arachidic acid	0.25	0.29	0.30	0.22	0.25	0.26	0.23
C22:0 Behenic acid	0.10	0.24	00.0	0.17	00.0	0.15	0.11
Total saturated fatty Acids (TSFA)	**61.88**	**51.30**	**49.40**	**56.15**	**55.98**	**50.71**	**54.06**
Mono unsaturated Fatty Acids (MUFA)							
C14:1Tetradeconic Acid	0.86	0.87	0.29	0.37	0.33	0.28	0.75
C15:1 14, Pentadecenooic Acid	0.28	0.20	0.29	0.27	0.26	0.16	0.18
C16:19Hexadecenoic Acid	1.77	1.72	1.24	1.44	1.41	1.22	1.65
C17:1 Heptadecenoic Acid	0.43	0.41	0.21	0.32	0.25	0.22	0.23
C18:1 Oleic acid	23.24	26.20	25.03	23.80	23.52	24.86	26.74
C20:1 Gadoleic	0.38	0.32	0.25	0.24	0.23	0.24	0.30
Total Mono unsaturated fatty Acids (TMUFA)	**26.96**	**29.72**	**27.31**	**26.44**	**26.00**	**26.98**	**29.85**
Poly unsaturated Fatty Acids (PUFA)							
C18:2 linoleic acid	5.88	12.90	17.47	10.42	11.69	16.77	11.35
C18:2 T linoleic acid	1.04	1.51	0.61	0.73	0.72	0.84	0.83
C18:3 n-6 linolenic acid	0.29	0.28	0.09	0.10	0.10	0.09	0.20
C18:3 n-3 Linolenic acid	0.95	0.94	0.73	0.73	0.92	0.88	0.72
C20:4 Arachidonic acid	-	-	0.08	0.11	0.13	0.08	-
Total Poly unsaturated Fatty Acids (TPUFA)	**8.16**	**15.63**	**18.95**	**12.09**	**13.56**	**18.66**	**13.10**
Total Unsaturated Fatty Acids (TUFA)	**35.12**	**45.35**	**46.29**	**38.53**	**39.56**	**45.64**	**42.95**
Total Fatty Acids	97.00	96.65	95.69	94.68	95.54	96.35	97.01
Unknown	3.00	3.05	4.31	5.25	4.46	3.65	2.80
total	**100.0**	**99.70**	**100.0**	**99.93**	**100.0**	**100.0**	**99.81**

Color measurements of selected mixed sweet biscuits:

Color is a vital quality attribute of foods and plays an important role in sensory and consumer acceptance of products which exists by Millard reaction during biscuit baking (Purlis, 2010).

The changes in the external color of resultant biscuits as influenced by supplementation of different suggested raw materials were studied and the obtained results are shown in Table (10).

It could be demonstrated that PG sample had the highest values of lightness (*L*), yellowness (*b*) and chroma (*c*) (70.17, 43.80 and 44.37, respectively.), while sample T3 had the lowest value of lightness (*l*), yellowness (*b*), chroma (*c*), and hue angle (*h*) (59.37, 23.56, 23.78 and 82.11, respectively) in comparison with control samples and other samples. WbR sample had the highest value of redness (*a*), while WbG sample had the lowest value of redness in comparison with control samples and other samples. The color intensity is related with many factors: the baking time of the dough; the contact and temperature in the baking plates or the colors formulation of raw materials, thus different colors originate were found (Purlis, 2010). The color of the top surface cookies was generated in the baking process possibly due to non-enzymatic browning (Maillard reactions) between reducing sugars and amino acids, but also possibly to starch dextrinisation and sugar caramelisation (Chevallier *et al*., 2000). It has also been reported that protein content has a negative correlation with the whiteness (Chevallier *et al*., 2000). The yellow color in the biscuit samples of PG, PR, and PWbis due to the presence of carotenoids in pumpkin in their biscuit blends.

Table (10): Color measurements of selected sweet biscuits

Parameters	Biscuit's samples						
	Con	PG	PR	PWb	WbG	WbR	T3
Lightness (*L)**	69.10[ab] ±0.05	70.17[a] ±0.05	67.77[bc] ±1.62	67.55[bc] ±2.05	69.71[a] ±0.67	65.97[c] ±0.00	59.37[d] ±0.25
Redness (*a)**	2.73[bc] ±0.24	2.67[cd] ±0.054	2.76[ab] ±0.68	3.05[ab] ±0.06	2.32[c] ±0.04	3.48[a] ±0.25	3.21[ab] ±0.47
Yellowness (*b)**	27.64[d] ±0.15	43.80[a] ±0.59	42.17[b] ±0.25	42.23[b] ±0.61	34.17[c] ±0.68	34.37[c] ±0.15	23.56[e] ±0.60
Chroma (*c)**	34.77[c] ±0.18	44.37[a] ±0.37	41.11[b] ±0.79	44.15[a] ±0.02	34.52[c] ±0.42	35.32[c] ±0.81	23.78[d] ±0.09
hue angle(*h°*)	85.23[c] ±0.33	87.21[a] ±0.16	86.31[b] ±0.30	86.19[b] ±0.37	87.31[a] ±0.42	81.81[d] ±0.94	82.11[d] ±0.06

Values are mean of three replicates ±SD.
The number in the same column followed by the same letter are not significantly different at 0.05.
L^*(Lightness with *L*=100 for lightness, and *L*=zero for darkness),*a** [(chromaticity on a green (−)to red (+)],*b**[(chromaticity on a blue (−)yellow (+)],*c**(color saturation),***h°***(hue angle where 0=red to purple, 90° =yellow, 180=blush to green and 270=blue scale.

Moisture content and Physical properties of selected mixed sweet biscuits:

Table (11), showed that moisture content of the different samples(as indicated by crispy) was found to vary between 3.34% forT3sample and 5.12% for PWb sample compared with 3.44 % for the control, and this may be due to the difference in water holding capacity and also to the composition of different formulas of these samples. The water activity (a_w) values of biscuit samples were in the range of 0.17 for WbR sample to 0.31 for PG sample compared with 0.20 for control. The drying process in biscuit manufacturing contributes to decreasing of the water activity. The water activity values of the biscuit indicate that values are in the safe range of keeping the quality. The water activity values of the biscuits are below the recommended water activity requirements for the growth of bacteria (a_w> 0.91) and molds (a_w>0.81). In addition to influencing microbial spoilage, water activity can play a significant role in determining the activity of enzymes and vitamins in foods and can have a major impact on their color، taste, and aroma (Chirife *et al*., 1996). A sample of biscuits are consider non-potentially hazardous because they had water activity less than 0.6 (Bolandi *et al*., 2008).

Spread ratio was calculated by dividing diameter by thickness. Thus, thicker biscuit will have lower spread ratio than a thinner biscuit, provided that the diameters of both biscuits are not significantly different. Lesser Spread ratio value of 6.62% was observed in the case of the control sample. Cookies with a higher value of spread ratio are more desirable (Eissa *et al*. 2007; Hussein *et al*., 2013).

Specific volume for produced types of biscuit was ranged from 5.33 cm^3/g for T3 to 6.95cm^3/g for PG compared with 7.69 cm^3/g for control. Also, the data outlined in the same Table represented that hardness of biscuit was significantly affected, except in the case of

PG sample. The lesser hardness values of 36.67 and 36.96 N were observed in control and PG samples, respectively. Hardness (breaking strength) measures the maximum force applied by the instrument to snap the biscuit into two pieces, thereby indicates the hardness of the biscuit. Hence, higher value indicates that the biscuit is harder. These results agreed with Hoojjat and Zabik (1984) and Lee; Beuchat (1991) who reported that more strength was needed to break cookies incorporated with legumes flour. This might have resulted from the incorporation of protein-rich flour which need more water to obtain good cookie dough, and the cookies prepared from high-absorption dough tend to be extremely hard.

Table (11): Moisture content and physical properties of selected sweet biscuits

Parameters	**Biscuit's samples**						
	Con	**PWb**	**PG**	**PR**	**WbG**	**WbR**	**T3**
Moisture (%)	3.44^{cd} ±0.46	5.12^{a} ±0.21	4.26^{b} ±0.33	3.72^{c} ±0.13	3.89^{bc} ±0.06	3.38^{d} ±0.08	3.34^{d} ±0.25
Water activity (a_w)	0.20^{c} ±0.01	0.30^{a} ±0.04	0.31^{a} ±0.00	0.29^{ab} ±0.00	0.20^{c} ±0.01	0.17^{d} ±0.00	0.27^{b} ±0.00
Diameter (mm)	39.69^{b} ±0.06	41.07^{a} ±0.69	41.06^{a} 0.19±	40.07^{ab} ±0.69	38.26^{c} ±1.38	40.69^{ab} ±0.07	39.63^{b} ±0.00
Thickness (mm)	6.00^{a} ±0.00	5.67^{ab} ±0.35	5.75^{ab} ±0.25	5.75^{ab} ±0.25	5.17^{c} ±0.35	5.37^{bc} ±0.13	4.5^{d} ±0.25
Spread ratio (%)	6.62^{c} ±0.01	7.26^{bc} ±0.33	7.15^{bc} ±0.35	6.97^{bc} ±0.19	7.44^{b} ±0.78	7.59^{b} ±0.19	8.83^{a} ±0.50
Spread factor	100^{d} ±0.00	110.22^{bc} ±4.82	108.01^{bcd} ±5.37	105.34^{cd} ±2.96	115.38^{ab} ±1.23	114.60^{abc} ±2.99	120.89^{a} ±1.58
Weight (g)	4.26^{d} ±0.09	5.11^{a} ±0.30	4.61^{bcd} ±0.23	4.83^{ab} ±0.21	4.42^{cd} ±0.25	4.77^{abc} ±0.04	4.27^{d} ±0.33
Volume (cm^3)	32.75^{a} ±0.25	32.75^{a} ±0.25	32.0^{a} ±1.00	31.50^{a} ±1.50	25.77^{c} ±0.25	29.0^{b} ±0.50	22.75^{d} ±1.75
Specific volume (cm^3/g)	7.69^{a} ±0.10	6.43^{cd} ±0.43	6.95^{b} ±0.13	6.52^{c} ±0.03	5.85^{e} ±0.39	6.09^{de} ±0.15	5.33^{f} ±0.00
Hardness (N)	36.67^{c} ±0.66	60.57^{a} ±1.70	36.96^{c} ±0.10	48.87^{abc} ±1.24	39.64^{bc} ±1.41	51.17^{ab} ±1.00	47.93^{bc} ±0.56

Values are mean ±SD.
Each value with the same row is followed by the same letters is not significantly different at the level of 0.05.

Changes in Peroxide values (PV) of biscuit lipids during storage at room temperature (20-25°C).

Peroxide value (PV) is an indicator for measuring oxidative deterioration of lipids and it's a good index for the quality of fat. Refined fats should have PV of less than 1 milli equivalent peroxide/Kg fats and fat that has been stored for some period of time after refining may have PV of up to 10 milli equivalent peroxide/Kg fats (Allen, 1983). The peroxide value estimated after baking, then during storage for2, 4 and 6 months is recorded in Table (12). The results revealed that the PV of all resultant biscuits increased with the increase of storage period up to 6 months. At the end of the storage period, the P.V value of all biscuits were lower than the permissible value (10 peroxide/ Kg fats according to the Egyptian Specification standard No 416 (2003). The PV of all biscuit samples at the end of storage period were lower than that of control except WbG and T3 samples. And the PR and WbR samples have the lowest value of PV at the end of storage period. These are due to deferent their content of the antioxidant (Priecinaand Karklina, 2014).

Changes in acid value (AV) of biscuit lipids during storage at room temperature (20-25°C):

The changes occurred in the A.V of biscuit lipids extracted from different biscuit treatment during the storage period of biscuit at room temperature are shown in Table (12). The AV for produced types of biscuit were ranged from 1.00 to 3.35 mg KOH/ g lipid after baking compared with 1.17 mg KOH/g lipid for control, and from 3.30 to 5.37 KOH/g lipid at the end of storage period compared with 2.34 mg KOH/g lipid for control. While the acid value of control and treatments increased at the end storage period, these are due to the moisture content increased.

Table (12): Changes in peroxide value and acid value of resultant sweet biscuit during storage at room temperature (20-25°C)

Type of biscuit	PV*				AV**			
	Storage period after				Storage period after			
	After baking	2 Month	4 months	6 months	After baking	2 months	4 months	6 months
Control	4.63[bc] ±0.13	4.65[d] ±0.26	5.39[f] ±0.30	8.12[b] ±0.06	1.17[de] ±0.11	1.23[f] ±0.15	2.30[d] ±0.10	2.34[d] ±0.26
PWb	**4.40[e] ±0.10**	7.80[b] ±0.15	7.94[b] ±0.07	8.00[b] ±1.00	1.00[e] ±0.50	2.33[de] ±0.08	2.98[c] ±0.03	3.30[c] ±1.10
PG	4.67[b] ±0.03	6.20[c] ±0.10	7.26[c] ±0.04	8.10[b] ±0.10	2.67 [b] ±0.03	2.67[c] ±0.02	3.56[b] ±0.09	3.61[c] ±0.11
PR	4.30[e] ±0.10	6.00[c] ±1.00	6.22[e] ±0.10	**6.70[c]** ±0.10	2.14[bc] ±0.06	3.20[b] ±0.10	4.08[a] ±0. 01	5.37[a] ±0.11
WbG	4.54[bcd] ±0.06	6.20[c] ±0.10	8.71[a] ±0.05	9.69[a] ±0.11	2.10 [c] ±0.10	2.47[d] ±0.14	2.89[c] ±0.05	3.40[c] ±0.10
WbR	6.11[a] ±0.03	6.56[c] ±0.11	6.90[d] ±0.10	7.31[c] ±0.11	3.35 [a] ±0.10	3.63[a] ±0.03	4.08[a] ±0.02	4.59 [b] ±0.03
T3	4.50[cd] ±0.10	8.73[a] ±0.12	8.86[a] ±0.04	9.17[a] ±0.06	1.43[d] ±0.07	2.25[e] ±0.10	2.30[d] ±0.10	3.39[c] ±0.09

* PV = Peroxide value (milli equivalent peroxides/Kg lipid).
** AV=Acid values (mg KOH/ g lipid).
Each value with the same row is followed by the same letters is not significantly different at the level of 0.05.

Changes occurred in sensory evaluation (Taste and odor) of resultant biscuit during storage period at room temperature (20-25°C):

Odor and taste are considered the most important characters that affect the quality of biscuit during storage. It was evident from the data in Table (13) that the characteristics of odor and taste decreased with the increase of storage period up to 6 months for all types of resultant biscuits. All types of resultant biscuits were accepted for odor and taste except control biscuit for taste after the 4 months of storage period. And all types of resultant biscuits were accepted for odor after the 6 months of storage period. With regard to the taste, all types of resultant biscuits and control biscuit were non-accepted except WbG, WbR, and T3 samples after the 6 months of storage period. Percentage of losses of odor for produced types of biscuit were ranged from 9.89% for WbR sample to 23.16% for PWb sample compared with 27.18% for control sample during storage for 6 months at room temperature. While the percentage of losses of taste for resultant types of biscuit were ranged from 14.44% for WbR sample to 29.68% for PWb sample compared with 37.17% for control sample during storage for 6 months at room temperature. In general, all samples of the resultant biscuits can be consumed within two months of production without any noticeable changes in both odor and taste.

A gradual decrease in overall acceptability of biscuit during storage was reported by Elahi (1999) who attributed it to moisture absorption, increase in peroxide value and free fatty acid contents in biscuits.

Microbiological evaluation of different types of the biscuits:

The total microbial and Yeast & Mold count of different types of biscuits were investigated to assess one of the most important factors in the evaluation of biscuits quality. Data in Table (14) indicated that no total microbial count was detected after 2 and 4 months for all types of produced biscuit except PWb and PG samples after 4 months. After 6 months of storage at room temperature (20-25°C) all types of biscuits appeared that microbial growth was detected. It's ranged from 1×10^3 cfu/g for WbR sample to 4×10^3 cfu/g for both in PWb and PR samples compared with 5×10^3 cfu/g for control. While all biscuits types appeared that no Yeast & Mold was detected during storage period up to 6 months at room temperature except for PR sample which recorded 1×10^3cfu/g, this microbial contamination may be occur during handling preparation or worker's hands or increased temperature degree during storage (Manley2011; Manley and Clark, 2011)

According to WHO Standard (1994) the maximum permissible limits in baked products (cake, bread and biscuit) for total plate count (TPC) is 2.0 $x10^5$ cfu $g^{-1}$and yeast and mold is < 1.0 $x10^4$ cfu g^{-1}. Thus, developed biscuit had a lower microbial profile (Table 14) compared to WHO Standards (1994). On the basis of these findings, it could be contended that the product is safe to consume.

Table (13): Mean values of odor and taste for resultant biscuit during storage at room temperature (20-25°C)

Type of biscuits	Odor (20)				% Losses on odor*	Taste (20)				% Losses on taste**
	Storage period (month)					Storage period (month)				
	0	2	4	6		0	2	4	6	
Control	19.5[a] ±0.71	18.2[b] ±0.42	15.2[b] ±0.79	14.2[c] ±0.79	**27.18**	19.1[a] ±1.10	17.0[b] ±0.00	12.4[b] ±2.55	12.0[c] ±2.26	**37.17**
PWb	19.0[a] ±0.67	18.6[a] ±0.97	17.2[b] ±1.23	14.6[c] ±2.07	**23.16**	18.2[a] ±1.23	17.7[a] ±0.49	15.2[b] ±0.42	12.8[c] ±2.44	**29.68**
PG	18.9[a] ±0.74	18.3[a] ±0.95	16.8[b] ±1.23	15.0[c] ±2.16	**20.63**	17.75[a] ±1.28	17.5[a] ±0.71	15.4[b] ±0.52	12.8[c] ±1.81	**27.89**
PR	18.6[a] ±0.97	18.3[a] ±0.49	16.8[b] ±1.03	16.4[b] ±2.88	**11.83**	17.4[a] ±1.17	17.2[a] ±0.79	15.6[b] ±1.84	13.8[c] ±2.62	**20.69**
WbG	18.5[a] ±1.27	18.3[a] ±1.06	16.2[b] ±2.94	15.4[b] ±1.57	**16.76**	18.2[a] ±0.27	17.7[a] ±0.82	15.8[b] ±1.69	15.0[b] ±1.89	**17.56**
WbR	18.2[a] ±0.91	17.8[ab] ±0.63	16.6[b] ±1.08	16.4[b] ±2.80	**9.89**	18.0[a] ±0.82	17.6[a] ±0.52	15.6[b] ±1.08	15.4[b] ±1.58	**14.44**
T3	18.4[a] ±1.43	18.3[a] ±1.50	15.3[b] ±1.06	14.8[b] ±2.44	**19.57**	18.1[a] ±1.10	17.9[a] ±0.88	15.0[b] ±1.16	14.2[b] ±2.44	**21.55**

Values with the same row followed by the same letters are not significantly different at the level of 0.05.
Score ≤14 non-acceptant.

Table (14): Microbiological analysis (cfu/g) of sweet biscuits during storage at room temperature (20-25°C)

Type of biscuit	Total plate count				Yeast & Mold			
	Storage period				Storage period			
	Zero time	After 2 months	After 4 months	After 6 months	Zero time	After 2 months	After 4 months	After 6 months
Con	ND	ND	ND	5×10^3	ND	ND	ND	ND
PWb	ND	ND	2×10^3	4×10^3	ND	ND	ND	ND
PG	ND	ND	1×10^3	3×10^3	ND	ND	ND	ND
PR	ND	ND	ND	4×10^3	ND	ND	ND	1×10^3
WbG	ND	ND	ND	2×10^3	ND	ND	ND	ND
WbR	ND	ND	ND	1×10^3	ND	ND	ND	ND
T3	ND	ND	ND	2×10^3	ND	ND	ND	ND

*ND = not detected

Percentages of the recommended dietary allowances (%RDA) provided from resultant biscuits:

A meal in a school day is of importance from nutritionally, socially and educationally concepts. The meal should be offered at the school to provide one-third of a child's daily requirements of protein, energy, and some minerals and vitamins (Morrison, 1996).

Adequate nutrient intake, especially of protein and micronutrients, enhances the growth of children and decreases susceptibility to disease (Kebebu *et al*., 2013).

The percentages of the recommended dietary allowances (% RDA) provided from 100g of resultant biscuits for children and adults (males and females) are shown in Tables (15, 16 and 17), it could be observed that all values of % RDA for protein, energy, minerals (*i.e.,* Iron, zinc, calcium, magnesium and manganese) and vitamins contents (*i.e.,* A, E, K and B1, B2, B3, B6 and B9) were high in all samples of supplemented biscuits compared with control un-supplemented biscuits.

Table (15): Percentage of the RDA of some nutrient provided from 100g biscuit for children

Age group	Nutrient	RDA*	% RDA from Biscuit samples**						
			Control	PWb	PG	PR	WbG	WbR	T3
Children (4-8) years	Carbohydrate	130 g	59.13	56.10	54.62	55.55	53.82	55.55	54.67
	Protein	19 g	40.00	47.26	42.74	44.58	45.63	46.58	46.21
	Energy	1742 K.cal	26.44	27.20	26.98	26.67	27.34	26.81	27.45
	Fe	10 mg	15.0	23.0	22.1	31.7	22.5	33.1	30.1
	Zn	5 mg	14.4	23.20	29.0	25.40	26.2	27.8	30.2
	Ca	1000 mg	1.32	3.11	1.83	1.92	2.33	2.39	2.39
	Mg	130 mg	8.89	13.69	11.05	13.75	11.85	14.68	13.67
	Mn	1.5 mg	24.67	33.33	18.67	38.00	32.67	56.00	54.67
	Vitamin A	400µg	30.16	36.89	36.70	36.50	30.37	30.19	32.07
	Vitamin E	7 mg	3.37	4.57	10.91	8.57	10.16	8.39	11.49
	Vitamin K	55 µg	0.32	2.42	0.37	0.57	2.26	2.46	1.38
	Thiamin B_1	6.0 mg	1.17	1.50	1.67	3.66	2.17	4.17	4.0
	Riboflavin B2	0.6 mg	3.67	6.0	7.83	5.5	9.0	7.83	6.17
	Nicotinic acid B3	8mg	9.0	9.25	10.75	32.38	11.88	33.38	33.88
	Pyridoxine B_6	0.6 mg	4.0	6.83	3.0	43.33	6.83	46.67	43.83
	Folate B9	200 µg	7.55	18.18	7.64	8.34	18.12	19.27	8.60
	B_{12}	1.2 µg	0.00	0.25	0.25	0.25	0.00	0.00	0.08

* Recommended dietary allowances from the Dietary Reference Intakes according to Food and Nutrition Board as reports by National Academy of Sciences (2004).
**% RDA=Value of nutrient in the sample of biscuit × 100 / RDA for the same nutrient.

Table (16): Percentage of the RDA of some nutrient provided from 100g biscuit for males

Age group	Nutrient	RDA*	% RDA from Biscuit samples**						
			Control	PWb	PG	PR	WbG	WbR	T3
Males (14-18) years	Carbohydrate	130 g	59.13	56.10	54.62	55.55	53.82	55.55	54.67
	Protein	52 g	14.62	17.27	15.62	16.29	16.67	17.02	16.88
	Energy	3152 K.cal	14.61	15.03	14.91	14.74	15.11	14.82	15.17
	Fe	11 mg	13.64	20.91	20.09	28.82	20.45	30.09	27.36
	Zn	11 mg	6.55	10.55	13.18	11.55	11.91	12.64	13.73
	Ca	1300 mg	1.02	2.39	1.41	1.47	1.79	1.83	1.84
	Mg	410 mg	2.82	4.34	3.50	4.36	3.76	4.65	4.33
	Mn	2.2 mg	16.82	22.73	12.73	25.91	22.27	38.18	37.27
	Vitamin A	900 µg	13.41	16.40	16.31	16.22	13.50	13.42	14.25
	Vitamin E	15 mg	1.57	2.13	5.09	4.00	4.74	3.91	5.36
	Vitamin K	75 µg	0.23	1.77	0.27	0.42	1.66	1.80	1.01
	Thiamin B_1	1.2 mg	5.83	7.50	8.33	18.33	10.83	20.83	20.00
	Riboflavin	1.3 mg	1.69	2.77	3.62	2.54	4.15	3.62	2.85
	Nicotinic acid B3	16 mg	4.50	4.63	5.38	16.19	5.94	16.69	16.94
	Pyridoxine B_6	1.3 mg	1.85	3.15	1.38	20.0	3.15	21.54	20.23
	Folate	400 µg	3.77	9.09	3.82	4.17	9.06	9.64	4.30
	B_{12}	2.4 µg	0.00	0.13	0.13	0.13	0.00	0.00	0.042

* Recommended dietary allowances from the Dietary Reference Intakes according to Food and Nutrition Board as reports by National Academy of Sciences (2004).
** % RDA=Value of nutrient in the sample of biscuit × 100 / RDA for the same nutrient.

Table (17): Percentage of the RDA of some nutrient provided from 100g biscuit for females

Age group	Nutrient	RDA*	% RDA from Biscuit samples**						
			Control	PWb	PG	PR	WbG	WbR	T3
Females (14-18) years	**Carbohydrate**	**130 g**	59.13	56.10	54.62	55.55	53.82	55.55	54.67
	Protein	**52 g**	16.52	19.52	17.65	18.41	18.85	19.24	19.09
	Energy	**3152 K.cal**	19.45	20.01	19.85	19.62	20.11	19.72	20.19
	Fe	**11 mg**	10.0	15.33	14.73	21.13	15.0	22.07	20.07
	Zn	**11 mg**	8.0	12.89	16.11	14.11	14.56	15.44	16.78
	Ca	**1300 mg**	1.02	2.39	1.41	1.47	1.79	1.83	1.84
	Mg	**410 mg**	3.21	4.94	3.99	4.96	4.28	5.30	4.94
	Mn	**2.2 mg**	23.13	31.25	17.50	35.63	30.63	52.50	51.25
	Vitamin A	**900 µg**	17.24	21.08	20.97	20.85	17.35	17.25	18.33
	Vitamin E	**15 mg**	1.57	2.13	5.09	4.00	4.74	3.91	5.36
	Vitamin K	**75 µg**	0.23	1.77	0.27	0.42	1.66	1.80	1.01
	Thiamin B_1	**1.2 mg**	7.0	9.0	10.0	22.0	13.0	25.0	24.0
	Riboflavin	**1.3 mg**	2.2	3.6	4.7	3.3	5.4	4.7	3.7
	Nicotinic acid B3	**16 mg**	5.14	5.29	6.14	18.50	6.79	19.07	19.36
	Pyridoxine B_6	**1.3 mg**	2.00	3.42	1.50	21,67	3.42	23.33	21.92
	Folate	**400 µg**	3.77	9.09	3.82	4.17	9.06	9.64	4.30
	B_{12}	**2.4 µg**	0.00	0.13	0.13	0.13	0.00	0.00	0.042

* Recommended dietary allowances from the Dietary Reference Intakes according to Food and Nutrition Board as reports by National Academy of Sciences (2004).
** % RDA=Value of nutrient in the sample of biscuit × 100 / RDA for the same nutrient

CONCLUSION

From this study, it could be concluded that incorporated of wheat flour with pumpkin, yellow corn germ, white kidney bean, rice bran and roselle flower rising nutritional values, minerals and vitamins content of resultant biscuits, and the best blend was found in WbR (80 % Wheat flour 72% extract+10%white kidney bean +10%heat stabilization rice bran). Newly prepared biscuits could be recommended as a food aid in institutional feeding programs for pupils in different school stages and adults as well. Also, it is easily to prepare by mothers at home to their family as a healthy diet.

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إعداد وتقييم بسكويت مدعم ببعض الإضافات الطبيعية لتغذية الأطفال والمراهقين

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تهدف هذه الدراسة إلى محاولة إعداد بسكويت صحي كوجبة سريعة للحد من أمراض سوء التغذية مثل الأنيميا و هشاشة العظام و المنتشرة بنسبة كبيرة بين الفئات العمرية المختلفة وخاصة بين الأطفال و المراهقين والتي تؤدي إلي عدم قدرة الإنسان علي العمل والإنتاج لتأثيرها السلبي علي النمو العقلي والجسمي في المستقبل. وتحقيقا لذلك أقترحت عدة نماذج لخلطات ثنائية أو عديدة بإستخدام ٥ أنواع من المدعمات الطبيعية (الفاصوليا البيضاء والقرع العسلي والكركدية وجنين الذرة ورجيع الكون) لتدعيم دقيق القمح إستخلاص ٧٢% وإستخدامها في إعداد البسكويت. آوضحت نتائج التقييم الحسي أن البسكويت الناتج من الخلطات التالية (٨٠% دقيق قمح + ١٠% قرع عسلي + ١٠% فاصوليا بيضاء) و(٨٠% دقيق قمح + ١٠% قرع عسلي + ١٠% جنين ذرة) و (٨٠% دقيق قمح + ١٠% قرع عسلي + ١٠% رجيع كون) و(٨٠% دقيق قمح + ١٠% فاصوليا بيضاء + ١٠% جنين ذرة) و(٨٠% دقيق قمح + ١٠% فاصوليا بيضاء + ١٠% رجيع كون) كخلطة ثنائية أو (٧٥% دقيق قمح + ١٠% رجيع كون +٥% فاصوليا بيضاء + ٥% جنين ذرة + ٣% قرع عسلي +٢% كركدية) كخلطة عديدة مازالت في نطاق درجة أفضلية جيد جدا لذا تم أختيارهم لتقييمهم كيمائيا وطبيعيا ودراسة جودة التخزين للبسكويت الناتج. أظهرت نتائج التقييم الكيميائي أن كل خلطات البسكويت السابقة هي الأعلي في محتواها من البروتين، الدهن، الرماد، الألياف الخام، السعرات الحرارية ومحتواها من العناصر المعدنية (لكل من الحديد والزنك والكالسيوم والمنجنيز والماغنسيوم) والفيتامينات (مثل أ، ه، ك، ب١، ب٢، ب٣، ب٦، ب٩) والأحماض الأمينية الأساسية والقيمة الحيوية للبروتين ونسبة كفاءة البروتين وكمية الأحماض الدهنية غير المشبعة. كما تحسنت خصائص اللون في العينات التي إحتوت علي القرع العسلي. ووجد زيادة في معامل التمدد و درجة الصلابة لكل أنواع البسكويت المدعم مقارنة مع الكنترول. وكانت كل أنواع البسكويت المدعمة هي الأعلي في تغطية معظم الإحتياجات اليومية الموصي بها لجميع المغذيات المدروسة السابقة لكل من الأطفال والبالغين مقارنة بالكنترول. وتوصي نتائج هذه الدراسة بإستخدام هذه المصادر الطبيعية مرتفعة القيمة الحيوية لعمل مخبوزات صحية عالية القيمة الحيوية وخاصة لمقاومة الأنيميا وهشاشة العظام نظرا لإرتفاع محتواها من المغذيات المطلوبة.