Assessment of Cookies Prepared by Substituting Wheat Flour with Lupine, Lentil and Coconut Flours to Combat Malnutrition

By

Manal M. E. M. Shehata

Food Sci. Dept. (Rural Home Economics - Food Science and Nutrition),
Fac. Agric., Zagazig Univ., Egypt

Research Journal Specific Education

Faculty of Specific Education

Mansoura University

ISSUE NO. 66, APRIL , 2022

مجلة بحوث التربية النوعية - جامعة المنصورة

العدد السادس والستون - أبريل ٢٠٢٢

ASSESSMENT OF COOKIES PREPARED BY SUBSTITUTING WHEAT FLOUR WITH LUPINE, LENTIL AND COCONUT FLOURS TO COMBAT MALNUTRITION

*Manal M. E. M. Shehata**

Abstract:

Low availability of healthy foods and inadequate consumption of protein-rich diets are the main causes of malnutrition. Current study was designed to develop cookies from sweet lupine (SLF), red lentil (RLF) and coconut flours (CF) and to assess the quality characteristics of the product. Ten formulations of samples were prepared from 100% wheat flour (WF) (T1); 80%WF+10%SLF+10%CF (T2); 60%WF+20%SLF+20%CF (T3); 40%WF+30%SLF+30%CF (T4); 80%WF+10%RLF+10%CF (T5); 60% WF+20% RLF+20%CF (T6); 40% WF+30% RLF+30%CF (T7); 70%WF+ 10%SLF+10%RLF+10%CF (T8); 55%WF+15%SLF+15%RLF+15%CF (T9); 40%WF+20%SLF+20%RLF+20%CF (T10). Results demonstrated that SLF contained the highest value of protein (39.80%) and fat (7.85%), while CF had the highest level of fiber (11.85%) and ash (4.31%) than other kinds of flour. The highest value of Ca, P, Mg and Zn were recorded in SLF, moreover RLF contained the highest level of K and Fe than other flours. Cookies were acceptable up to 20%SLF+20%CF; 20%RLF+20%CF and 15%SLF+15%RLF+15%CF. Protein levels of cookies (T3, T6 and T9) increased by 77.6, 59.7 and 79.1%, respectively, comparing with (T1). Ash levels in (T3, T6 and T9) were approximately 3-fold higher than (T1). Ca, P, K, and Mg contents in cookies significantly increased *($P \leq 0.05$)* as the amounts of SLF, RLF and CF were increased. No significant impact *($P \leq 0.05$)* on diameter, thickness & spread ratio of samples (T3, T6 and T9) comparing to (T1). T3, T6 and T9 contained higher values of amino acids than (T1). Consumption of T3, T6 and T9 can provide important ingredients to improve human nutritional quality and health status, so this study

* Food Sci. Dept. (Rural Home Economics - Food Science and Nutrition), Fac. Agric., Zagazig Univ., Egypt. E-mail: manal.m.e.shehata@gmail.com.

recommended using SLF, RLF and CF in food products preparation to combat malnutrition.

Key words: Cookies quality; sensory characteristics; legumes; minerals; amino acids

Introduction:

Good nutrition puts children on the way to survive and flourish. Well-nourished children grow, learn, develop, play, participate and contribute. whereas, malnutrition deprives children of their whole potential, with consequences for children, nations and the world **(WHO, 2021a)**.

Malnutrition comprises undernutrition (stunting, wasting and underweight), insufficient minerals or vitamins, overweight, obesity & noncommunicable diseases associated with diet **(WHO, 2021b)**. In 2020, 149.2 million children (<5 years old) were recorded to be stunted; 45.4 million were estimated to be wasted; moreover 38.9 million were determined overweight globally. In children less than 5 years old, about 45 percent of deaths are related to undernutrition, especially in low & middle-income countries **(WHO, 2021a)**. In adults, 1.9 billion were recorded to be overweight or obese, whereas 462 million were recorded as being underweight globally **(WHO, 2021b)**. People in developing countries, such as Egypt, mostly eat starchy diets, which lead to malnutrition, and children being the worst affected. Protein Energy Malnutrition (PEM) is the most common cause of diseases in children like Kwashiorkor & Marasmus. Malnutrition is considered a huge burden on Egypt's economy. Undernutrition is manifested by the high prevalence of stunting, wasting & deficiencies in micronutrients in children, and by anemic women of childbearing age, which collectively consumes a 2% of Egypt's yearly gross domestic product through forgone productivity and health care costs, resulting in an annual economic hemorrhaging of billions of dollars per year **(Herbst *et al.*, 2020)**. In Egypt, 20 – <30% (high level), 10 – <15% (high level) and 5 – <10% (medium level) of children < 5 years old affected by stunting, overweight and wasting, respectively **(WHO, 2021a)**.

Bakery and pastry products are consumed worldwide in large quantities on a daily basis and play a vital role in human nutrition. Among bakery products, cookies hold an important place in snacks due to their taste, crispness, eating convenience, long shelf life and low manufacturing cost, and a rich source of carbohydrate & fat. Generally, cookies are prepared from refined WF, shortening, sugar and some other additives. These kinds of ingredients are low in nutritive and biological values because refined WF is low in protein, fiber, minerals & vitamins and rich in carbohydrate (**Chauhan *et al.,* 2016)**. Thus, the low nutritional value of cookies is a main concern because cookies are the most popular snacks eaten by children in school, who need more protein per unit weight than adults. Accordingly, it is vital to produce cookies with high nutritional value. So, looking for a protein source that can provide WF with an appropriate amount of protein which turn will help to improve the nutritional value of cookies that can be utilized in diet and nutrition programmers **(Obeidat *et al.,* 2013)**.

Lupine is a legume that belongs to the *Leguminosae* family. Lupine (*Lupinus albus*) seeds, has higher protein (~40%), high number of essential amino acids (EAAs), important dietary minerals and lower fat values which attract it as a great food ingredient **(Guemes-Vera *et al.,* 2012)**. Lupine seeds (LS) are a cheap alternative to other legume crops importantly soybean as it has comparable quantities of protein with similar amino acid profile. LS have significant contents of polyphenols, phytosterols, carotenoids, tocopherols, alkaloids and peptides with antioxidant, antimicrobial, anticarcinogenic and anti-inflammatory activities **(Khan *et al.,* 2015)**.

Lentil (*Lens culinaris*) is a nutritious and common food all over the world especially in the developing countries. Lentil seeds have a high-protein source (22 - 34.6%) and also rich in important vitamins (B1, B2, B3, B9, pantothenic acid and pyridoxine), minerals (Ca, Mg, Fe, Mn, Cu, Co, Ni, B and Se) and soluble & insoluble dietary fiber **(Devisetty *et al.,* 2019)**. lentil contains bioactive compounds like polyphenols (tannins, flavones, phenolic compounds), phytosterols, phytate, vitamins, minerals, protein, resistant starch, oligosaccharides, bioactive peptides and saponins. All these ingredients are responsible for health improving effects **(Zhang *et al.*, 2014)**.

Coconut (*Cocos nucifera*) is one of the palm species belongs to the family *Arecaceae*. Coconut flour (CF) is a vital by-product obtained from coconut residues produced through the wet processing of coconut to extract milk or dry processing to extract oil **(Adeloye *et al.*, 2020)**. CF has high values of health promoting fiber, protein and other nutrients. CF contains a low level of digestible carbohydrate, does not contain gluten, and is inexpensive than other nut flours and tastes wonderful. CF can be utilized much like WF to make of delicious breads, cookies, pies, cakes, desserts and snacks. CF provides many health benefits. It can improve digestion, help prevent heart disease, diabetes and cancer, moreover aid in weight loss **(Ramaswamy, 2014)**.

There is urgent need to make strategic use of low-cost and high-protein resources that complement the balanced amino acid profile of staple diets to enhance nutritional value & combat malnutrition in developing countries. Among processed foods, bakery foods are popular with people of all ages in both rural & urban areas. Lupine and lentil are lower in cost comparing with other similar legumes. Coconut is inexpensive and highly palatable. Therefore, this paper was designed to assess physical properties, nutritional composition & sensory evaluation of cookies prepared from lupine, lentil and coconut flours to combat malnutrition.

Materials and Methods:

Materials:

Sweet lupine, red lentil, coconut, wheat flour (WF), shortening, whole milk powder, sugar, salt, baking powder and vanilla were bought from local market in Sharkia Governorate, Egypt. Chemicals used in the current study were bought from El-Gomhoriya Company for Trading Drugs, Chemicals and Medical Instruments, Sharkia Governorate, Egypt. All chemicals and reagents were of analytical grade.

Methods:

Preparation of lupine, lentil and coconut:

Sweet lupine and red lentil seeds were ground in blender for getting flour. Coconut flour was prepared by **Afoakwah *et al.*, (2019)** method. Grated coconut was put in boiling water and was blended in a mixer to obtain a smooth paste. The milk was separated using muslin cloth. The residue was washed by hot water to decrease the fat content and was dried to a stable weight at 60°C. The dried sample was milled to flour, sieved and packaged in air-tight plastic bags. All types of flour were stored in an air sealed container till use.

Cookies Making:

Cookies were prepared by the procedure of **Ghoshal and Kaushik, (2020)**. The basic ingredients used were WF (100g), sugar (45g), shortening (25g), whole milk powder (5g), baking powder (0.4g), salt (1g), vanilla (0.2ml) and water as required. The experiment consisted of ten formula, namely T1-Cookies made by 100g (WF); T2 – 80g (WF) + 10g (SLF) + 10g (CF); T3 –60g (WF) + 20g (SLF) + 20g (CF); T4 – 40g (WF) + 30g (SLF) + 30g (CF); T5 – 80g (WF) + 10g (RLF) + 10g (CF); T6 – 60g (WF) + 20g (RLF) + 20g (CF); T7 – 40g (WF) + 30g (RLF) + 30g (CF); T8 –70g (WF) + 10g (SLF) + 10g (RLF) + 10g (CF); T9 – 55g (WF) + 15g (SLF) + 15g (RLF) + 15g (CF); T10 – 40g (WF) + 20g (SLF) + 20g (RLF) + 20g (CF). All kinds of cookies were prepared as follows. Sugar and shortening with vanilla were creamed in a blender, and then whole milk powder was added. Samples flour, baking powder and salt were added, and were mixed with water to get cookies dough. The dough was rolled out to a thin thickness (5.0 mm), and it was cut with a cookie cutter (35.0 mm diameter). Cookies were baked at 160°C for 25 min in oven, and then were allowed to cool at room temperature. Cookies were packaged in polyethylene bags and stored in air-tight containers till evaluation.

Chemical composition of cookie samples & energy value:

Protein, fat, fiber, ash and moisture were examined for raw materials & cookie samples as described in **AOAC, (2012)**. Calculations of total carbohydrates were by difference. Calculation of energy value (EV) was done by utilizing the Atwater factors (9, 4 and 4 kcal/g) of fat, carbohydrate and protein, respectively (**Chaney, 2006)**. Minerals level (Ca, K, Zn, Fe and Mg) were estimated by Atomic Absorption Spectrophotometer (Hitachi Z6100, Tokyo, Japan) according to **AOAC, (2012)**. While, phosphorus (P) level was determined by the phosphovanado-molybdate (yellow) method **(AOAC, 2012)**.

Determination of physical quality of cookies:

Diameter, thickness and spread ratio of cookies were measured according to **(Man *et al.*, 2017)**.

Color analysis of cookies:

The color analysis of the prepared cookies was assessed using a Hunter Lab color analyzer (Hunter Lab Color Flex EZ, USA) to estimate L^* value (light – dark), a^* value (red – green) and b^* value (yellow – blue). The total color difference (ΔE) was calculated as **Shrestha *et al.*, (2012)** method.

Determination of amino acids:

Amino acids of different kinds of cookies were obtained using an automatic amino acid analyzer model S 433 (Sykam, Eresing, Germany) according to **AOAC (2006)**.

Sensory characteristics of cookies:

Cookies were assessed for color, taste, texture, flavor, appearance in addition overall acceptability. Sensory characteristics were carried out using a 9-point Hedonic scale from “like extremely” to “dislike extremely”. Cookies were presented to twenty trained panelists who were chosen from Faculty’s staff (**Sulthana *et al.*, 2018)**.

Statistical Analysis:

Results (three replicates) were evaluated by using the Statistical Package for Social Sciences (SPSS) version 25.0, (2017) (IBM Corp., Armonk, New York). One-way analysis of variance test was done to test differences between treatments, followed by mean separation using Duncan's analysis. Results with a *($P \leq 0.05$)* were considered to be statistically significant **(Bailey, 1995)**.

Results and Discussion:

Chemical composition of WF, SLF, RLF and CF flours:

The proximate chemical composition of WF**,** SLF, RLF and CF are clarified in Table (1). There was a significant variation *($p \leq 0.05$)* in overall composition of four flours. Protein, fat, fiber, ash and moisture values of CF were 23.51, 4.86, 11.85, 4.31 and 5.51%, respectively. According to **Makinde and Eyitayo, (2019)**, the chemical analysis of CF was 23.6% protein, 5.4% fat, 5.21% ash, 11.14% fiber and 5.52% moisture. SLF contained the highest level of protein 39.80% and fat 7.85%, but it had the lowest carbohydrate content (29.45%) comparing with RLF, CF and WF. Meanwhile, CF contained the highest amount of fiber (11.85%) and ash (4.31%) comparting to SLF, RLF & WF, and WF contained the highest value of carbohydrate (74.06%) and moisture (11.27%) in comparison with SLF, RLF & CF. WF contained significantly lower value *($p \leq 0.05$)* of protein (12.10%), ash (0.51%) and fiber (1.00%) comparing with SLF, RLF and CF. **Man *et al.*, (2021)** recorded that WF contained 9.12% protein, 1.03% fat, 0.48% ash, 0.37% fiber and 74.45% carbohydrate. **Kefale and Yetenayet, (2020)** stated that SLF had 7.65% (fat), 4.20% (ash), 35.08% (protein) and 7.00% (moisture). Protein, fat, fiber, ash & moisture levels of RLF were 25.30, 1.30, 4.40, 3.00 and 8.40%, respectively. Chemical analysis of RLF estimated during this study is in concurrence with obtained results of **Bouhlal *et al.*, (2019)** for protein, fat & carbohydrate. CF contained 4.37% moisture, 19.47% protein and 3.54% ash **(Raczyk *et al.*, 2021)**.

Table (1): Chemical composition of WF, SLF, RLF and CF (on a fresh weigh base).

Component %	Raw Material			
	WF	SLF	RLF	CF
Moisture	11.٢٧±0.26^{a}	8.25±٠.14^{b}	8.40±٠.12^{b}	5.51±0.10^{c}
Protein	1٢.١0±0.20^{d}	39.80±0.27^{a}	25.30±0.22^{b}	23.51±٠.20^{c}
Fat	1.06 ±0.0٤^{c}	7.85±0.21^{a}	1.30±0.02^{c}	4.86±٠.١0^{b}
Fiber	١.0٠±0.0٢^{d}	10.75±0.25^{b}	4.40±0.15^{c}	11.85±0.24^{a}
Ash	0.51±0.01^{c}	3.٩٠±0.10^{ab}	3.00±0.12^{b}	4.31±0.11^{a}
Carbohydrate	74.06±0.40^{a}	٢9.45±0.25^{d}	57.60±0.40^{b}	49.96±0.35^{c}

Means having different letters within the row are significant difference *(p≤0.05)* according to Duncan's test. WF: Wheat flour**; SLF:** Sweet lupine flour; **RLF:** Red lentil flour and **CF:** Coconut flour.

Minerals content of WF, SLF, RLF and CF flours:

Minerals content of WF, SLF, RLF and CF is explained in Table (2). A significant difference *(p≤0.05)* was noticed among WF, SLF, RLF and CF in minerals content. Results indicated that the lowest content of calcium (23.90), phosphorus (93.00), potassium (135.23), magnesium (43.34), iron (1.21) and zinc (1.40) mg/100g were recorded in WF compared with SLF, RLF and CF. Minerals content of RLF were 98.5, 456, 1200, 135, 8.6 and 4.5 mg/100g for Ca, P, K, Mg, Fe and Zn, respectively. Current results of minerals level in WF and RLF showed some variation comparing with data obtained by **AwadElkareem and Al-Shammari, (2015)** who found that minerals content of WF were 16.21 (Ca), 118.12 (P), 107.21 (K), 19.13 (Mg) and 4.54 (Fe) mg/100g, whereas RLF contained 118.2, 226.12, 650.51, 4.03 and 5.32 mg/100g of Ca, P, K, Mg and Fe, respectively. The highest amount of Ca, P, Mg and Zn were determined in SLF comparing to RLF, CF & WF. Moreover, RLF contained the highest content of K and Fe compared with SLF, CF & WF. **Jahreis *et al.*, (2016)** stated that lupine had 220 (Ca), 407 (P), 116 (K), 162 (Mg), 4.6 (Fe) and 3.7 (Zn) mg/100g.

Table (2): Minerals content of WF, SLF, RLF and CF (on a fresh weigh base).

Mineral (mg/100g)	Raw Material			
	WF	SLF	RLF	CF
Calcium	23.90±0.40[d]	280.00±1.00[a]	98.50±0.90[c]	110.00±1.00[b]
Phosphorus	93.00±0.60[d]	470.00±1.40[a]	456.00±1.20[b]	215.00±1.10[c]
Potassium	135.23±1.11[d]	650.00±1.70[c]	1200.00±2.50[a]	755.00±1.45[b]
Magnesium	43.34±0.50[d]	190.00±1.14[a]	135.00±1.22[b]	95.00±0.80[c]
Iron	1.21±0.03[d]	5.30±0.11[b]	8.60±0.20[a]	3.00±0.10[c]
Zinc	1.40±0.04[c]	5.50±0.12[a]	4.50±0.12[b]	0.06±0.01[d]

Means having different letters within the row are significant difference *($p \leq 0.05$)* according to Duncan's test. WF: Wheat flour**; SLF:** Sweet lupine flour; **RLF:** Red lentil flour and **CF:** Coconut flour.

Chemical composition of cookies:

The chemical composition of cookies is clarified in Table (3). Results indicated that replacement of WF by SLF + CF, RLF + CF and SLF + RLF + CF would result in a significant increase *($P \leq 0.05$)* in protein, fat, fiber, ash and moisture levels of cookies, while carbohydrate and energy values significantly decreased *($P \leq 0.05$)* comparing with control cookies. These results might be because of SLF, RLF and CF have higher values of protein, fiber, fat & ash comparing with WF. All ingredients contents except carbohydrate and energy values significantly increased *($P \leq 0.05$)* with increasing the contents of SLF, RLF and CF flours added to cookie samples comparing with (T1). Similar findings were obtained from substituting tef flour by lupine flour in injera (bread) production for protein, fiber, fat, carbohydrate and ash **(Yegrem *et al.,* 2021)**. Cookies produced with lentil flour and WF have a significant elevate in protein and insoluble fiber **(Portman *et al.,* 2020)**. The rusk with 20% defatted coconut flour + 4% dry gluten powder + 0.002% fungal α-amylase had 5.5, 1.6 times higher dietary fiber and protein comparing with control rusk, respectively **(Chandrashekar *et al.,* 2019)**. Findings indicated that the highest moisture percentage (3.70%) was estimated in (T4), whereas the lowest level (2.00%) was determined in control (T1). These findings perhaps are result to the elevate in fiber amount of the cookies by the incorporation of SLF + CF, RLF + CF and SLF + RLF + CF, which probably causes a significant elevate in water absorption capacity. Similar result was published by **Afoakwah *et al.*, (2019)** for cake made from WF and CF. The highest protein level (17.75%) was estimated in cookies prepared with 30% SLF + 30% CF, whereas the lowest protein level (8.36%) was determined in control. Also, the highest fiber, ash & fat levels were estimated in cookies containing 30% SLF + 30% CF compared with (T1). These results might be because of SLF and CF have higher values of protein, fiber, fat & ash comparing with WF. Protein values of cookies (T4, T7 and T10) increased by 112, 84 and 104%, respectively, comparing to (T1). Protein levels of cookies (T3, T6 and T9) increased by 77.6, 59.7 and 79.1%, respectively, comparing with control (T1). Fat contents of cookies (T4, T7 and T10) increased by 13.6, 5.2 and 9.5%, respectively, comparing to control cookies (T1), while fat levels of cookies (T3, T6 and T9) increased by 9.0, 3.7 and 6.9%, respectively, comparing with control (T1). Ash contents in (T4, T7 and T10) were approximately 4-fold more than control. Whereas in (T3, T6 and T9) were approximately 3-fold higher than (T1). Fiber amounts in (T4, T7 and T10) were approximately 7-times, 5-times and 6-times, respectively, more than control cookies. Whereas in (T3, T6 and T9) were approximately 5-times, 4-times and 5-times, respectively, higher than (T1). Energy value of cookies in treatments (T4, T7 and T10) was 3.81, 3.83 and 3.58% lower than control, respectively, whereas for (T3, T6 and T9) was 2.79, 2.73 and 2.80% lower than (T1), respectively.

According to the **WHO (2007)** expert consultation, the protein requirements of children aged 3-10 and 10-18 years are 0.73 and 0.7 g/kg/day, respectively. Based on **FAO (2004)** weight for age values, the daily protein requirements for these children 11-22 and 24-40 g/day for 3-10 and 10-18 years old, respectively. According to the **FAO/ WHO/ UNU (2001)** the energy requirements of children aged 7-8, 8-9, 9-10, 10-11 and 11-12 years are 1623, 1764, 1916, 2078 and 2245 Kcal/day in the mean, respectively. Cookies containing 20% SLF + 20% CF provide 14.85g protein and 447.98 Kcal energy per 100g weight. Therefore, consumptions of 50 and 100g of cookies would provide 50% of the daily protein intake for children aged 3-10 and 10-18 years, respectively, and provide 27.6, 25.4, 23.4, 21.6 and 20.0%, respectively, from the daily energy requirements for children aged 7-8, 8-9, 9-10, 10-11 and 11-12 years, respectively. Results of (T6) and (T9) are the same as T3 findings because they have approximately the same range of protein & energy values as (T3).

Table (٣): Chemical composition of cookies containing SLF, RLF and CF (on a fresh weigh base).

Sample	Component						
	Moisture %	**Protein %**	**Fat %**	**Fiber %**	**Ash %**	**Carbohydrate %**	**EV Kcal/100g**
T1	2.00 ±0.10[d]	8.36 ±0.20[i]	14.70 ±0.24[f]	0.63 ±0.01[g]	0.53 ±0.01[e]	73.78 ±0.55[a]	460.86 ±2.32[a]
T2	2.80 ±0.11[bc]	11.45 ±0.21[g]	15.26 ±0.25[de]	1.94 ±0.02[ef]	1.01 ±0.01[d]	67.54 ±0.45[c]	453.30 ±2.20[c]
T3	3.30 ±0.12[abc]	14.85 ±0.22[d]	16.02 ±0.24[b]	3.22 ±0.03[bc]	1.51 ±0.01[abc]	61.1 ±0.38[fg]	447.98 ±2.15[d]
T4	3.70 ±0.11[a]	17.75 ±0.23[a]	16.70 ±0.25[a]	4.45 ±0.04[a]	1.90 ±0.02[a]	55.5 ±0.35[i]	443.30 ±2.00[f]
T5	2.60 ±0.12[cd]	10.75 ±0.21[h]	14.96 ±0.23[ef]	1.52 ±0.01[f]	0.97 ±0.01[d]	69.20 ±0.45[b]	454.44 ±2.22[b]
T6	3.10 ±0.13[abc]	13.35 ±0.23[e]	15.24 ±0.22[de]	2.44 ±0.02[d]	1.44 ±0.02[bc]	64.43 ±0.40[e]	448.28 ±2.12[d]
T7	3.40 ±0.14[ab]	15.40 ±0.22[c]	15.47 ±0.25[cd]	3.29 ±0.03[bc]	1.84 ±0.02[ab]	60.60 ±0.38[g]	443.23 ±2.10[f]
T8	2.70 ±0.12[bc]	12.70 ±0.21[f]	15.43 ±0.23[cd]	2.16 ±0.02[de]	1.17 ±0.03[cd]	65.84 ±0.42[d]	453.03 ±2.11[c]
T9	3.20 ±0.13[abc]	14.97 ±0.22[d]	15.71 ±0.24[bc]	2.95 ±0.02[c]	1.50 ±0.02[abc]	61.67 ±0.41[f]	447.95 ±2.10[d]
T10	3.60 ±0.14[b]	17.07 ±0.24[b]	16.10 ±0.26[b]	3.65 ±0.03[b]	1.79 ±0.02[ab]	57.79 ±0.34[h]	444.34 ±2.00[e]

Means having different letters within the column are significant difference *($p\leq0.05$)* according to Duncan's test. EV: Energy value. **T1:** 100% WF**; T2:** 80% WF+10% SLF+10% CF**; T3:** 60% WF+20% SLF+20% CF**; T4:** 40% WF+30% SLF+30% CF**; T5:** 80% WF+10% RLF+10% CF**; T6:** 60% WF+20% RLF+20% CF**; T7:** 40% WF+30% RLF+30% CF**; T8:** 70% WF+10% SLF+10% RLF+10% CF**; T9:** 55% WF+15% SLF+15% RLF+15% CF and **T10:** 40% WF+20% SLF+20% RLF+20% CF.

Minerals content of cookies:

Table (4) shows minerals level of cookies. Ca, P, K, and Mg contents of control cookies were 15.50, 59.30, 83.20 and 26.60 mg/100, which significantly increased *($P\leq0.05$)* gradually as the level of substitution of SLF, RLF and CF were increased. Similarly, the zinc and iron amounts of the samples with SLF, RLF and CF showed an increasing trend as the value of substitution increased. From the analysis, the iron content of (T6), (T7), (T9) and (T10) significantly elevated *(P≤0.05)*, moreover zinc level significantly increased *(P≤0.05)* in (T3), (T4), (T8), (T9) and (T10) compared to (T1). Calcium, potassium, iron, magnesium and zinc were significantly elevated in lupine biscuits **(Štefániková *et al.*, 2020)**. Ca, Fe, K, Zn and Mg values were significantly elevated *(P<0.05)* in maize-defatted coconut flour blends **(Adeloye *et al.*, 2020)**. A significant difference *(p<0.05)* was noticed between WF and fortified wheat-lentil flours for zinc and iron levels **(Bouhlal *et al.*, 2019)**. The highest level of phosphorus (166.40 mg/100) was determined in (T10), which was almost 3-fold comparing with (T1). This finding perhaps is attributed to elevate the value of phosphorus in SLF, RLF and CF than WF (Table 2). The maximum potassium (395.00 mg/100) and iron (2.48 mg/100) levels were recorded in (T7), which were approximately 5-times and 3-times, respectively, more than control cookies. These results probably are because of the highest level of K and Fe in RLF compared to SLF, CF and WF (Table 2). The highest calcium (80.00 mg/100) and magnesium (63.00 mg/100) amounts were determined in (T4), which were about 5-times and 2-times, respectively, more than (T1). These findings perhaps are result to the highest content of Mg and Ca in SLF compared to RLF, CF and WF (Table 2). The zinc value of cookies ranged from 0.85 to 1.55 mg/100. The highest zinc value was estimated in (T10), whereas the lowest content was determined in control cookies (T1). These findings probably are result to SLF and RLF contain higher values of zinc than WF.

Table (4): Minerals content of cookies containing SLF, RLF and CF (on a fresh weigh base).

Sample	Mineral (mg/100g)					
	Calcium	**Phosphorus**	**Potassium**	**Magnesium**	**Iron**	**Zinc**
T1	١٥.٥٠ $\pm0.20^{i}$	٥٩.٣٠ $\pm0.72^{h}$	٨٣.٢٠ $\pm0.80^{j}$	٢٦.٦٠ $\pm0.40^{h}$	٠.٧٦ $\pm0.02^{c}$	٠.٨٥ $\pm0.01^{d}$
T2	٣٧.٠٠ $\pm0.60^{g}$	٩٠.٥٠ $\pm0.95^{g}$	١٥١.٦٠ $\pm1.00^{i}$	٣٨.٨٠ $\pm0.57^{f}$	1.١3 $\pm0.03^{bc}$	١.٠١ $\pm0.02^{bcd}$
T3	٦٠.٣٠ $\pm0.70^{c}$	١٢٢.٦٠ $\pm1.13^{e}$	٢١٧.٠٠ $\pm1.43^{g}$	٥٢.٠٠ $\pm0.62^{d}$	١.٥٥ $\pm0.05^{abc}$	١.٢٠ $\pm0.04^{abc}$
T4	٨٠.٠٠ $\pm0.90^{a}$	١٥٢.٨٠ $\pm1.25^{b}$	٢٨٨.٦ $\pm1.33^{d}$	٦٣.٠٠ $\pm0.70^{a}$	١.٨٦ $\pm0.06^{abc}$	١.٣٤ $\pm0.04^{ab}$
T5	٢٥.٦٠ $\pm0.80^{h}$	٨٩.٣٠ $\pm0.81^{g}$	١٨٩.٢٠ $\pm1.29^{h}$	٣٥.٢٠ $\pm0.55^{g}$	١.٣٤ $\pm0.04^{abc}$	٠.٩4 $\pm0.02^{cd}$
T6	٣٧.٠٠ $\pm0.65^{g}$	١٢١.٤٠ $\pm1.14^{e}$	٢٩٥.٠٠ $\pm1.40^{c}$	٤٥.٠٠ $\pm0.70^{e}$	١.٩٥ $\pm0.05^{ab}$	1.02 $\pm0.03^{bcd}$
T7	٤٥.٨٠ $\pm0.66^{e}$	١٤٩.٠٠ $\pm1.20^{c}$	٣٩٥.٠٠ $\pm1.60^{a}$	٥٢.٢٠ $\pm0.75^{d}$	٢.٤٨ $\pm0.07^{a}$	١.١1 $\pm0.04^{bcd}$
T8	٤١.٦٠ $\pm0.60^{f}$	١١٢.٨٠ $\pm1.00^{f}$	٢١٨.٦٠ $\pm1.40^{f}$	٤٤.١٠ $\pm0.50^{e}$	١.٦٠ $\pm0.03^{abc}$	1.18 $\pm0.03^{bc}$
T9	٥٧.٠٠ $\pm0.70^{d}$	١٤١.٦٠ $\pm1.20^{d}$	٢٨٦.٢٠ $\pm1.44^{e}$	٥٣.٥٠ $\pm0.63^{c}$	٢.٠٥ $\pm0.04^{ab}$	1.34 $\pm0.03^{ab}$
T10	٦٧.٧٠ $\pm0.82^{b}$	١٦٦.٤٠ $\pm1.30^{a}$	٣٥٠.٩٠ $\pm1.55^{b}$	٦١.٥٠ $\pm0.75^{b}$	٢.٤٢ $\pm0.06^{a}$	١.٥1 $\pm0.04^{a}$

Means having different letters within the column are significant difference *($p\leq0.05$)* according to Duncan's test. T1: 100% WF**; T2:** 80% WF+10% SLF+10% CF**; T3:** 60% WF+20% SLF+20% CF**; T4:** 40% WF+30% SLF+30% CF**; T5:** 80% WF+10% RLF+10% CF**; T6:** 60% WF+20% RLF+20% CF**; T7:** 40% WF+30% RLF+30% CF**; T8:** 70% WF+10% SLF+10% RLF+10% CF**; T9:** 55% WF+15% SLF+15% RLF+15% CF and **T10:** 40% WF+20% SLF+20% RLF+20% CF.

Sensory characteristics of cookies:

The descriptive sensory analysis values for prepared cookies are clarified in Fig (1). The data indicated that non-significant changes *($p\leq0.05$)* were observed among control cookies (T1) and (T2, T3. T5, T6, T8 and T9) in appearance, color, texture & overall acceptability scores. The colors of cookie samples (T1, T2, T3, T5, T6, T8 and T9) was attractive to the panelists comparing with other cookies. The highest score for taste was estimated in (T9), whereas other samples did not determine any significant changes ($p\leq0.05$) in the score of taste comparing with control. The flavor significantly improved *($p\leq0.05$)* in all cookie samples comparing with control (T1). Biscuits containing 25% of lupine flour demonstrated no significant difference in color comparing with the control **(Štefániková *et al.*, 2020)**. Cookies prepared with RLF were acceptable up to 50 percent, without any significant negative impact in aroma, taste and texture (**Ashraf *et al.*, 2012)**. Biscuit made from 50% WF + 25% CF + 25% almond flour did not estimate any significant changes in appearance, taste, aroma & overall acceptability scores comparing with control **(Noah, 2018)**. The content of CF up to 40 percent given the highest scores in flavor, odor & overall acceptability of the biscuit comparing to control **(Jiamjariyatam *et al.*, 2021)**.

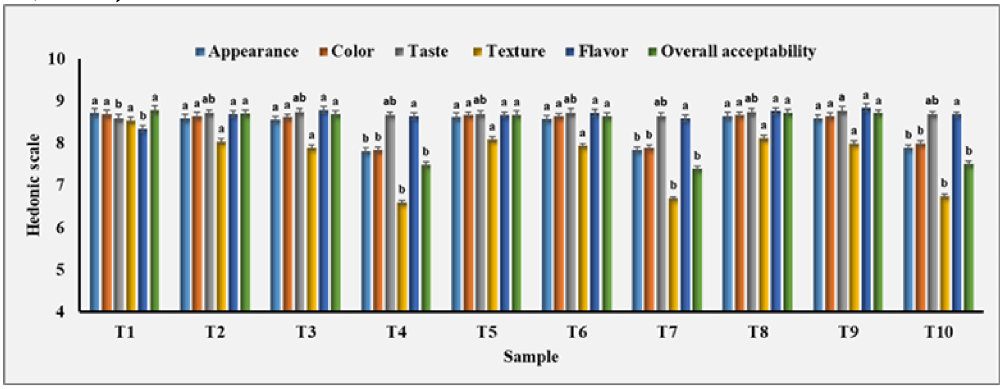

Fig. (1): Sensory characteristics of cookies.

Physical quality of cookies:

Table (5) summarizes the finding of the physical quality of samples. The replacement of WF with SLF, RLF and CF up to 20% SLF + 20% CF, 20% RLF + 20% CF and 15% SLF + 15% RLF + 15% CF had no significant impact *($p \leq 0.05$)* on diameter, thickness & spread ratio of samples comparing to control cookies. Diameter in (T4) and (T10) significantly decreased *($p \leq 0.05$)*, whereas spread ratio in (T4), (T7) and (T10) significantly decreased *($p \leq 0.05$)* comparing to (T1). While, in (T4), (T7) and (T10) thickness significantly increased *($p \leq 0.05$)* comparing with control. These findings probably are result to (T4), (T7) and (T10) contained the highest level of protein comparing with other cookies. Replacing WF with lupine flour up to 40 percent did not appear a significant impact on diameter of biscuit, but thickness elevated at ≥ 20% comparing with control

(Jayasena and Nasar-Abbas, 2011). According to **Sujirtha and Mahendran, (2015)**, the diameter was increased in biscuits made from defatted CF (9.2% fat), where the increase in the fat value led to an increase in the diameter, and biscuits thickness were reduced as the value of substitution of defatted CF increased. The diameter of biscuit was significantly elevated with increasing the lentil flour level from 5 to 20%, while no effect was shown on the thickness of biscuit **(Grah *et al.*, 2014)**.

Table (5): Physical quality of cookies containing SLF, RLF and CF.

Sample	Physical quality		
	Diameter (mm)	**Thickness (mm)**	**Spread ratio**
T1	35.90±0.30[a]	5.80±0.03[c]	6.19±0.04[a]
T2	35.8٨±0.22[a]	5.84±0.04[c]	6.14±0.03[a]
T3	35.٨٥±0.21[a]	٥.٩١±0.04[bc]	٦.٠٧±0.02[a]
T4	35.40±0.20[b]	6.٥٠±0.05[a]	5.٤٥±0.01[b]
T5	35.91±0.31[a]	5.82±0.03[c]	6.17±0.03[a]
T6	35.92±0.30[a]	5.90±0.03[bc]	6.09±0.02[a]
T7	35.94±0.33[a]	6.٣0±0.04[ab]	5.70±0.02[b]
T8	35.8٩±0.27[a]	5.81±0.02[c]	6.18±0.04[a]
T9	35.٨٧±0.25[a]	5.92±0.03[bc]	6.06±0.02[a]
T10	35.60±0.21[b]	6.40±0.05[a]	5.57±0.02[b]

Means having different letters within the column are significant difference *(p≤0.05)* according to Duncan's test. T1: 100% WF**; T2:** 80% WF+10% SLF+10% CF**; T3:** 60% WF+20% SLF+20% CF**; T4:** 40% WF+30% SLF+30% CF**; T5:** 80% WF+10% RLF+10% CF**; T6:** 60% WF+20% RLF+20% CF**; T7:** 40% WF+30% RLF+30% CF**; T8:** 70% WF+10% SLF+10% RLF+10% CF**; T9:** 55% WF+15% SLF+15% RLF+15% CF and **T10:** 40% WF+20% SLF+20% RLF+20% CF.

Color analysis of cookies:

In the current research, the *L** value of cookies was decreased while the *a** and *b** values were increased comparing to (T1) (Table 6). The elevate in *a** and *b** values perhaps result to increase redness in RLF and yellowness in SLF. The *L** values representing lightness did not determine any significant changes *(p≤0.05)* in cookie samples (T2 and T3), whereas the other cookies revealed a significant decrease *(p≤0.05)* in lightness because of the loss of white color of the WF with the addition of SLF and RLF comparing with (T1). The *a** values (red – green) for samples (T2, T3 and T4) did not appear significant changes *(p≤0.05)*, whereas the other cookies significantly increased *(p≤0.05)*, especially in cookies prepared from RLF + CF comparing with (T1). This finding probably is as a result of RLF has natural red pigments. Moreover, the highest *b** values (yellow – blue) were recorded in cookies made from SLF + CF, comparing with control. These findings perhaps are the result of SLF contains natural yellow pigments. According to **Jayasena *et al.*, (2011),** *L** and *a** values of lupine biscuits did not determine any significant changes $(p \leq 0.05)$ up to 20 percent substitution. *L** value was decreased for raw & cooked pasta with increasing RLF, while a significant elevate $(p<0.05)$ was observed for the cooked pasta in *a** value with 5–20% addition of RLF comparing with control. Also, samples with RLF were marked by yellow color (*b**) **(Teterycz *et al.*, 2020)**. ΔE values that reflect the overall difference in color from the control cookies clarified a significant elevate $(p \leq 0.05)$ with the elevate in SLF + CF, RLF + CF and SLF + RLF + CF. The highest ΔE value was noticed in cookies produced with 30% RLF + 30% CF. A similar trend was recorded by **Teterycz *et al.*, (2020)** for pasta with addition of RLF. Also, the same findings were published by **Jayasena *et al.*, (2011)** who observed that an elevate in ΔE with the elevate in lupine flour substitution in biscuits.

Table (6): Color analysis of cookies containing SLF, RLF and CF.

Sample	Cookie color			
	L*	***a****	***b****	**Δ*E***
T1	79.١٠±0.92[a]	0.48±0.01[f]	19.29±0.10[g]	0.00±0.00[h]
T2	7٨.48±0.84[ab]	0.62±0.02[f]	22.67±0.15[c]	3.44±0.03[f]
T3	78.11±0.80[ab]	٠.٨٠±0.02[f]	24.٠7±0.24[b]	4.89±0.04[d]
T4	77.٦9±0.73[bc]	1.٠٠±0.03[f]	25.23±0.25[a]	6.13±0.06[b]
T5	77.86±0.74[b]	3.25±0.04[cd]	2٠.03±0.13[fg]	3.12±0.03[g]
T6	75.93±0.70[d]	٥.64±0.05[b]	2٠.40±0.16[f]	6.16±0.04[b]
T7	73.٨8±0.63[e]	7.60±0.07[a]	2٠.84±0.18[ef]	8.96±0.07[a]
T8	77.٥5±0.77[bc]	٢.٠٠±0.02[e]	٢١.٣٠±0.12[de]	2.96±0.02[g]
T9	7٦.٥٠±0.65[cd]	٢.٨٠±0.03[d]	٢١.٨٠±0.14[cd]	4.29±0.03[e]
T10	75.55±0.51[d]	٣.٥١±0.05[c]	٢٢.٤٠±0.15[c]	5.61±0.04[c]

Means having different letters within the column are significant difference *(p≤0.05)* according to Duncan's test. T1: 100% WF**; T2:** 80% WF+10% SLF+10% CF**; T3:** 60% WF+20% SLF+20% CF**; T4:** 40% WF+30% SLF+30% CF**; T5:** 80% WF+10% RLF+10% CF**; T6:** 60% WF+20% RLF+20% CF**; T7:** 40% WF+30% RLF+30% CF**; T8:** 70% WF+10% SLF+10% RLF+10% CF**; T9:** 55% WF+15% SLF+15% RLF+15% CF and **T10:** 40% WF+20% SLF+20% RLF+20% CF.

Amino acids of cookies:

The incorporation of cereal & legume proteins could provide better overall EAAs balance. Most cereals contain a low amount of protein, which is one of the causes of malnutrition in most African countries. Blending cereals with a high level of protein & low-cost legumes like lupine and lentil may be recommended. The amino acids of food products are a necessary for protein quality. The EAAs are needed for tissue maintenance and required for growth of children. Findings clarified that the substitution of WF with SLF + CF, RLF + CF and SLF + RLF + CF elevated protein amount and protein quality (EAAs profile) as explained in Table (7). Results indicated that cookie samples (T3, T6 and T9) contained higher amounts of the EAAs and non- essential amino acid (NEAAs) than control cookies (T1). The highest amount of leucine (0.921%) & threonine (0.505%) were estimated in (T3), while valine (0.578%), methionine (0.476%), isoleucine (0.500%), phenylalanine (0.545%) and lysine (0.697%) were recorded in (T9) comparing with control (T1). These findings probably are result to SLF, RLF and CF contain higher values of protein than WF. Whereas, the highest content of total EAAs were recorded in (T3), the increase was found to be 48% comparing with control (T1). Generally, the incorporation of 20% SLF + 20% CF, 20% RLF + 20% CF and 15% SLF + 15% RLF + 15% CF into the produced cookies led to an elevate of all amino acids comparing to the control. All amino acids of biscuits were gradually increased by replacing WF with SLF (4, 8 and 12%) **(El-Maasoud and Ghaly, 2018)**. Valine, methionine, leucine, isoleucine, threonine and lysine significantly increased *(P<0.05)* with increased substitution of CF and fluted pumpkin seed flour **(Oyet and Chibor, 2020)**. A significant elevates in leucine & phenylalanine was noticed in pasta with RLF **(Teterycz *et al.*, 2020)**.

Table (7): Amino acids content of cookies containing SLF, RLF and CF.

Amino acid (%)	Sample			
	T1	T3	T6	T9
Essential amino acid (EAA)				
Valine	0.410	0.554	0.492	0.578
Methionine	0.323	0.564	0.352	0.476
Leucine	0.599	0.921	0.684	0.909
Isoleucine	0.291	0.491	0.367	0.500
Threonine	0.371	0.505	0.377	0.493
Phenylalanine	0.428	0.533	0.466	0.545
Lysine	0.444	0.674	0.533	0.697
Total (EAA)	2.866	4.242	3.271	4.198
Non- essential amino acid (NEAA)				
Histidine	0.229	0.313	0.252	0.315
Tyrosine	0.193	0.388	0.232	0.367
Cystine	0.112	0.156	0.115	0.147
Arginine	0.476	0.915	0.699	0.915
Serine	0.334	0.617	0.404	0.593
Glycine	0.488	0.598	0.462	0.574
Alanine	0.374	0.530	0.396	0.509
Aspartic acid	0.550	1.066	0.742	1.063
Glutamic acid	0.921	1.858	1.345	1.856
Proline	0.690	0.886	0.584	0.808
Total (NEAA)	4.367	7.327	5.231	7.147
Total amino acids	7.233	11.569	8.502	11.345

T1: 100% WF**; T3:** 60% WF+20% SLF+20% CF**; T6:** 60% WF+20% RLF+20% CF and **T9:** 55% WF+15% SLF+15% RLF+15% CF.

Conclusion:

SLF, RLF and CF were utilized to substitute WF at various levels to prepare cookies. Replacing WF with 20% SLF + 20% CF, 20% RLF + 20% CF and 15% SLF + 15% RLF + 15% CF led to significant improvement in protein, fat, fiber, ash, Ca, P, K, Fe, Zn, Mg and amino acids levels without negatively affecting of physical, color and sensory properties of cookies. Compared to other natural protein sources, SLF, RLF and CF are less expensive. So, using of SLF, RLF and CF would elevate the nutritional value & quality of cookies at a relatively lower cost. In general, (T3), (T6) and (T9) can provide important ingredients to improve human nutritional quality & health status, so these cookies can help combat malnutrition.

Findings obtained could be very valuable in decision for manufacturers to use SLF, RLF and CF as a substitute or supplement to cereal flours for the manufacture of different bakery foods and also it would be of economic importance to exploit the local agriculture products in Egypt.

References:

Adeloye, J. B., Osho, H. and Idris, L. O. (2020). Defatted coconut flour improved the bioactive components, dietary fiber, antioxidant and sensory properties of nixtamalized maize flour. J. Agric. and Food Res. 2: 100042.

Afoakwah, N. A., Owusu, J. and Owusu, V. (2019). Characteristics of coconut (*Cocos nucifera*) flour and its application in cake. Asian Food Sci. J. 13(1): 1-11.

AOAC, (2012). Official Methods of Analysis. Association of Official Analytical Chemistry (A.O.A.C) International, 19th ed., Gaithersburg, Maryland, USA.

AOAC (2006). Official Methods of Analysis of the Association of Official Analytical Chemists. Washington, D.C. Determination of amino acids, eighteenth Ed., 4: 17–19.

Ashraf, S., Saeed, S. M., Sayeed, S. A., Kanwar, H., Ahmed, M. and Ali, R. (2012). Impact of lentil fortification on physical, chemical and instrumental properties of dough and its influence on overall quality of cookies. Arab Gulf J. Sci. Res. 30: 125-134.

AwadElkareem, A. M. and Al-Shammari, E. (2015). Nutritional and sensory evaluation of wheat flour biscuits supplemented with lentil flour. Pak. J. Nutr. 14(12): 841- 848.

Bailey, N. T. (1995). Statistical Method in Biology. 3rd Cambridge Univ. Press, Cambridge.

Bouhlal, O., Taghouti, M., Benbrahim, N., Benali, A., Visioni, A. and Benba, J. (2019). Wheat-lentil fortified flours: health benefits, physicochemical, nutritional and technological properties. J. Mater. Environ. Sci. 10(11):1098-1106.

Chandrashekar, S., Thangaraj, J. and Dasappa, I. (2019). Effect of partially defatted coconut flour on the rheological, physico-sensory characteristics and fatty acid profile of no-added fat rusk. Int. J. Food Sci. 54(5): 1769-1776.

Chaney, S. G. (2006). Principles of Nutrition I: Macronutrients. In: Devlin, T.M. (ed.), Textbook of Biochemistry, with Clinical Correlation, 6th ed. John Wiley and Sons, New York, pp: 1071-1090.

Chauhan, A., Saxena, D. C. and Singh, S. (2016). Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. Cogent Food and Agric. 2(1): 1125773.

Devisetty, G. K., Abatashi, O., Salim, U. and Said, Z. (2019). Metal composition and essential nutrient analysis in various colours of lentils determination of levels of essential nutrients and compositional analysis of metals in lentil. Res. J. Pharm. Biol. and Chem. Sci. 10(1): 655-659.

El-Maasoud, A. and Ghaly, M. (2018). Influence of addition sweet lupine flour on quality and antioxidant characteristics of biscuits. J. Food and Dairy Sci. 9(5): 163-170.

FAO, (2004). Human Energy Requirements: Report of a joint WHO/FAO/UNU expert consultation group. Food and nutrition technical report series 1. Food and Agriculture Organization: Rome.

FAO/WHO/UNU, (2001). Human Energy Requirement. Report of joint FAO/ WHO/ UNU Expert consultation, Rome, 17-24 Oct.

Ghoshal, G. and Kaushik, P. (2020). Development of soymeal fortified cookies to combat malnutrition. Legum. Sci. 2(3): e43.

Grah, A. B., Beda, M. Y., Aubin, P. D., Niaba, K. P. V. and Gnakri, D. (2014). Manufacture of biscuit from the flour of wheat and lentil seeds as a food supplement Eur. J. Food Sci. and Technol. 2(2): 23-32.

Guemes-Vera, N., Martinez-Herrera, J., Hernandez-Chavez, J. F., Yanez-Fernandez, J. and Totosaus, A. (2012). Comparison of chemical composition and protein digestibility, carotenoids, tanins and alkaloids content of wild lupinus varieties flour. Pak. J. Nutr. 11(8): 676–682.

Herbst, C. H., Elshalakani, A., Kakietek, J., Hafiz, A. and Petrovic, O. (2020). Scaling Up Nutrition in the Arab Republic of Egypt: Investing in a Healthy Future. International Development in Focus, World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/32599 License: CC BY 3.0 IGO.

Jahreis, G., Brese, M., Leiterer, M., Schafer, U. and Bohm, V. (2016). Legume flours: nutritionally important sources of protein and dietary fiber. Ernahr. Umsch. 63(02): 36-42.

Jayasena, V. and Nasar-Abbas, S. M. (2011). Effect of lupin flour incorporation on the physical characteristics of dough and biscuits. Qual. Assur. Saf. Crops and Foods. 3(3): 140-147.

Jiamjariyatam, R., Roskhrua, P. and Attiwittayaporn, S. (2021). Effect of coconut flour on biscuit quality. J. Culin. Sci. &Technol. 1-15.

Kefale, B. and Yetenayet, B. (2020). Evaluation of bread prepared from composite flour of sweet lupine and Bread wheat variety. J. Food Sci. and Nutr. The. 6(1): 007-010.

Khan, M. K., Karnpanit, W., Nasar-Abbas, S. M., Huma, Z. E. and Jayasena, V. (2015). Phytochemical composition and bioactivities of Lupine: A review. Int. J. Food Sci. & Technol. 50(9): 2004-2012.

Makinde, F. and Eyitayo, A. O. (2019). The evaluation of nutritional composition and functional and pasting properties of wheat flour-coconut flour blends. Croat. J. Food Sci. and Technol. 11(1): 21-29.

Man, S. M., Stan, L., Păucean, A., Chiş, M. S., Mureşan, V., Socaci, S. A., Pop, A. and Muste, S. (2021). Nutritional, sensory, texture properties and volatile compounds profile of biscuits with roasted flaxseed flour partially substituting for wheat flour. Appl. Sci. 11(11): 4791.

Man, S., Păucean, A., Muste, S., Chiș, M. S., Pop, A. and Ianoş, I. D. C. (2017). Assessment of amaranth flour utilization in cookies production and quality. J. Agroaliment. Process. Technol. 23 (2): 97-103.

Noah, A. A. (2018). Production, nutrient and sensory qualities of biscuits produced from wheat-coconut-almond flour blend. Int. J. Food Sci. and Nutr. 3(6): 302-306.

Obeidat, B. A., Abdul-Hussain, S. S. and Al Omari, D. Z. (2013). Effect of addition of germinated lupin flour on the physiochemical and organoleptic properties of cookies. J. Food Process. and Preserv. 37(5): 637-643.

Oyet, G. I. and Chibor, B. S. (2020). Amino acid profile, mineral bioavailability, and sensory properties of biscuits produced from composite blends of wheat, coconut and defatted fluted pumpkin seed flour. Eur. J. Agric. and Food Sci. 2(6).

Portman, D., Maharjan, P., McDonald, L., Laskovska, S., Walker, C., Irvin, H., Blanchard, C., Naiker, M. and Panozzo, J. F. (2020). Nutritional and functional properties of cookies made using down-graded lentil–A candidate for novel food production and crop utilization. Cereal Chem. 97(1): 95-103.

Raczyk, M., Kruszewski B. and Michałowska, D. (2021). Effect of coconut and chestnut flour supplementations on texture, nutritional and sensory properties of baked wheat based bread. Molecules. 26(15): 4641.

Ramaswamy, L. (2014). Coconut flour–a low carbohydrate, gluten free flour. Int. J. Ayurvedic and Herb. Med. 4(1): 1426-1436.

Shrestha, A. K., Arcot, J., Dhital, S. and Crennan, S. (2012). Effect of biscuit baking conditions on the stability of microencapsulated 5-methyltetrahydrofolic acid and their physical properties. Food and Nutri. Sci. 3(10): 1445-1452.

Štefániková, J., Valková, V., Nagyová, V., Hynšt, M., Miškeje, M., Borotová, P., Vietoris, V., Árvay, J. and Bojňanská, T. (2020). The influence of lupine flour on selected parameters of novel bakery products. Czech J. Food Sci. 38(6): 367-374.

Sujirtha, N. and Mahendran, T. (2015). production, quality assessment and shelf life evaluation of protein–rich biscuits made from blends of wheat and defatted coconut flours. In Proceeding of the 2nd International Conference on Agriculture and Forestry. 1: 19-27.

Sulthana, S. A., Maloo, S. S. and Bhasker, V. (2018). Formulation and quality evaluation of cookies from drumstick leaf powder and cauliflower leaf powder. Int. J. Adv. Res. 6(4): 168-172.

Teterycz, D., Sobota, A., Zarzycki, P. and Latoch, A. (2020). Legume flour as a natural colouring component in pasta production. J. Food Sci. and Technol. 57(1): 301-309.

WHO, (2021a). Levels and trends in child malnutrition: UNICEF/WHO/ The World Bank Group joint child malnutrition estimates: key findings of the 2021 edition.

WHO, (2021b). Fact sheets – Malnutrition. Accessed 9 June 2021. Available from https://www.who.int/news-room/fact-sheets/detail/malnutrition.

WHO, (2007). Protein and Amino Acids Requirements in Human Nutrition: Report of a joint WHO/FAO/UNU expert consultation (2002). WHO technical report series NO. 935 World Health Organization press: Geneva.

Yegrem, L., Abera, S. and Temesgen, M. (2021). Nutritional composition and sensory quality of injera prepared from tef (*Eragrostis tef* (Zucc.) Trotter) complemented with lupine (*Lupinus* spp.). Cogent food agric. 7(1): 1862469.

Zhang, B., Deng, Z., Tang, Y., Chen, P., Liu, R., Ramdath, D. D., Liu, Q., Hernandez, M. and Tsao, R. (2014). Fatty acid, carotenoid and tocopherol compositions of 20 Canadian lentil cultivars and synergistic contribution to antioxidant activities. Food Chem. 161: 296-304.

تقييم الكوكيز المحضر باستبدال دقيق القمح بدقيق الترمس والعدس وجوز الهند لمكافحة سوء التغذية

منال محمد السيد محمد شحاتة*

الملخص العربي:

يُعد قلة توافر الأطعمة الصحية والاستهلاك غير الكافي للأنظمة الغذائية الغنية بالبروتين من الأسباب الرئيسية لسوء التغذية. تهدف الدراسة الحالية لتطوير تحضير الكوكيز بدقيق الترمس الحلو (SLF) والعدس الاحمر (RLF) ودقيق جوز الهند (CF) وتقييم خصائص جودة المنتج. تم تحضير عشر عينات من الكوكيز وهى مكونة من ١٠٠٪قمح (T1) و٨٠٪قمح +١٠٪ترمس+١٠٪جوز الهند (T2) و٦٠٪قمح+٢٠٪ترمس+٢٠٪جوز الهند (T3) و٤٠٪قمح +٣٠٪ترمس+٣٠٪جوز الهند (T4) و٨٠٪قمح+١٠٪عدس+١٠٪جوز الهند (T5) و٦٠٪قمح+٢٠٪ عدس+٢٠٪جوز الهند (T6) و٤٠٪قمح+٣٠٪عدس+٣٠٪جوز الهند (T7) و٧٠٪قمح +١٠٪ترمس +١٠٪عدس+١٠٪جوز الهند (T8) و٥٥٪قمح+١٥٪ترمس+١٥٪عدس+١٥٪جوز الهند (T9) و٤٠٪ قمح+٢٠٪ترمس+٢٠٪ عدس+٢٠٪جوز الهند (T10). أظهرت النتائج أن الترمس يحتوي على أعلى قيم للبروتين (٣٩,٨٠٪) والدهون (٧,٨٥٪)، بينما جوز الهند احتوى على أعلى مستويات من الألياف (١١,٨٥٪) والرماد (٤,٣١٪) مقارنة بالانواع الآخري من الدقيق. تم تسجيل أعلى قيم للكالسيوم والفسفور والماغنسيوم والزنك في الترمس، علاوة على ذلك، احتوى العدس على أعلى مستويات من البوتاسيوم والحديد بالمقارنة بالانواع الآخري من الدقيق. وكانت الكوكيز مقبولة حتى ٢٠٪ترمس+٢٠٪جوز الهند و٢٠٪عدس+٢٠٪جوز الهند و١٥٪ترمس+١٥٪عدس+١٥٪جوز الهند. وزادت مستويات البروتين في الكوكيز (T3 وT6 وT9) بنسبة ٧٧,٦٪ و٥٩,٧٪ و٧٩,١٪ على التوالي مقارنة بالكنترول (T1). وكانت مستويات الرماد في (T3 وT6 وT9) أعلى بثلاثة أضعاف من (T1). وزادت محتويات الكالسيوم والفسفور والبوتاسيوم والماغنسيوم في الكوكيز معنوياً ($P \leq 0.05$) بزيادة كميات الترمس والعدس وجوز الهند. ولا يوجد اختلافاً معنوياً ($P \leq 0.05$) في قطر وسمك ونسبة انتشار العينات (T3 وT6 وT9) مقارنة بالكنترول(T1). واحتوت العينات T3 وT6 وT9 على قيم أعلى من الأحماض الأمينية من (T1). وأثبتت الدراسة أن استهلاك الكوكيز T3 وT6 وT9 يمكن أن يوفر مكونات مهمة لتحسين جودة التغذية للانسان والحالة الصحية، لذلك تُوصي هذه الدراسة باستخدام الترمس والعدس وجوز الهند في تحضير المنتجات الغذائية لمكافحة سوء التغذية.

الكلمات المفتاحية: جودة الكوكيز؛ الخصائص الحسية؛ البقوليات؛ المعادن؛ الاحماض الامينية.

* قسم علوم الأغذية شعبة الاقتصاد المنزلي الريفي (التغذية وعلوم الاطعمة) –كلية الزراعة –جامعة الزقازيق– مصر