

## Formulation and Evaluation of Some Novel Breakfast Blends Made from Cereals and Legumes

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### ABSTRACT

Four samples of breakfast cereal-legume blends were generated by mixing the flours (wheat, maize, rice, lentil, bean, chickpeas and kidney beans) with almond, bran and dates, in addition to others additives such as powdered skimmed milk, honey, baking powder, baking soda and flavoured (vanillin + cinnamon). Gelatinization of the grains and legumes starch was produced by roasting to obtain ready to eat breakfast cereal products. They were subjected to proximate, sensory, minerals, vitamins, anti-nutrients and acrylamide analysis. The products obtained were also served dry with warm milk to 10 panelists along with control sample to be evaluated for colour, taste, odour, texture and overall acceptability using a 9 point hedonic scale. The results showed the following ranges: Proximate composition (%): Moisture (12.95- 16.67), protein (7.71-13.06), crude ether extract (4.48-7.99), ash(2.30-2.52), carbohydrate (62.84-71.80), crude fiber (3.13-3.98) Energy ranged from 358.36 to 375.71kcal. Minerals analysis reported the following ranges (mg/100g):Fe (3.55-4.93),Zn (8.60-9.38), Mn (0.85-1.63), Ca(429.55-641.19), Mg(91.33-94.80), Na(24.66-39.17) and K (4.94-5.52). Vitamins analysis revealed the following ranges (mg/100g): Ascorbic acid (5.86-7.68), B<sub>2</sub>(1.46-1.68), B<sub>3</sub>(3.94-4.64), B<sub>9</sub>(0.487-0.585), β-carotene (3.91-6.16), E(4.24-5.63). The anti-nutritional factors showed the ranges: Trypsin inhibitor (13.61TIU/mg-24.71TIU/mg), phytic acid (129.10mg/100g-220.77mg/100g), haemagglutinating activities (128.59U/100g-284.50U/100g), alkaloids (64.69 mg/100g-183.33mg/100g), and oxalic acid (19.77mg/100g-88.93mg/100g). Protein digestibility exhibited values ranged from 83.20 % to 90.11%. The acrylamide content of the four blends ranged from 281.18μg/kg to 363.00μg/kg.

**Key words:-Breakfast cereal-legume blends, acrylamide, anti-nutritional factors.**

### INTRODUCTION

The benefit of human health was related to the consumption of wholegrain cereal in breakfast. Due to all the cereals contained bran, germ and endosperm, it is found to be reliable source of protein, fibers, vitamins and minerals. Consumption of breakfast cereals made from whole grains (wheat and oats) can reduce coronary heart disease risk (Woods & Walker, 2007).

The annual world production from cereal is more than 2.5 billion tons. All whole cereals are starchy foods and also considered as good source of energy, vitamins B, dietary fiber and protein. On the other hand, all cereals lack in the essential amino acids which are necessary for children development (Zhai *et al.*, 2015). Fortunately, legumes are good source of proteins and allow consumers to choose healthier types of ready to eat foods. (Gupta & Sehgal, 1991).

The manufacturing technique of breakfast cereal products was a multi-step, firstly cold water and/or heat are added in conditioning step, this step to adjust the structure of grain physically and give rise additional functions. Manufacturers treat using heat to carry out a desirable flavour “nutty flavour” and put on diverse levels of moisture for grain’s that immediately will be used for hot cereal or for flour. Grains are milled for flour or steamed and rolled into flakes. Finally, grains become able to be identified from the consumers as hot cereals (Berkenkamp *et al.*, 2015). Supplementation with a very high protein crop suitable as weaning foods is necessary to solve the starvation and obesity problems in the World. This supplementation was as formulation of cereal-legume blends for children of weaning age (Wakil & Kazeem, 2012). These supplements as food formulations were known as functional foods which are concerning the food manufacturers. A food can be made functional by applying any technological

means to take off or change in the components, as efficiently as, to get better its bioavailability to receive functional effects (Niva, 2007).

The aim of the present study is to formulate and evaluate some novel breakfast blends made from cereals and legumes.

## MATERIALS AND METHODS

### Materials

The seeds of wheat, corn, rice, lentil, bean, chickpeas and kidney bean were obtained from the local market, Alexandria, Egypt. The clean seeds were kept at room temperature in air tight containers.

### Methods

#### Processing procedure

**Soaking:** The seeds were steeped in double amount of water at ambient temperature for 12 hr and drained.

**Roasting:** The drained seeds were roasted in an oven at 280°C for 5min.

The roasted seeds were ground in electric mill (mesh size 0.5mm) separately. The flours thus obtained and powder were thoroughly blended with the same ratios to obtain the composite seed flour.

**Breakfast Cereals-Legume Blends:** The prepared recipes are shown in Table (1).

**Processing:** According to Fast (1990), the breakfast cereal-legume blends were prepared as shown in Fig (1).

#### Sensory evaluation

The four samples formulated in the present study were served to 10 trained panelists from the students of the University of Alexandria. The pan-

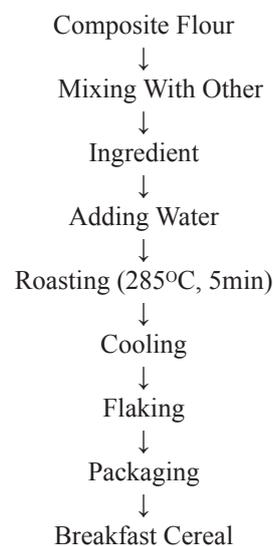
elists were asked to judge the samples on 9-point Hedonic scale. The samples and the control were served dry with warm milk and evaluated corresponding colour, taste, odour, texture and overall acceptability (Meilgaard *et al.*, 1991).

### Nutrient analysis

#### Gross chemical composition

The breakfast cereals were analyzed for moisture, crude protein ( $N \times 6.25$ ), crude ether extract, ash and carbohydrate (by difference) according to the AOAC (2007). Crude fibers were determined by the AOAC (2007).

Caloric values were calculated from the sum of the percentages of crude protein and total carbohydrates multiplied by a factor of 4 ( $Kcal.g^{-1}$ ) plus the crude fat content multiplied by 9 ( $Kcal.g^{-1}$ ) according to Zambrana *et al.* (2004).



**Fig 1: Flow diagram showing the procedure to prepare breakfast cereal- legume blends**

**Table 1: Ingredients combination for breakfast cereals-legume blends**

Ingredients (%)	Control	**Dates (Ajwa)	**Nuts (Almond)	Wheat bran
Composite flour*	90	70	70	70
Other additive	0	20	20	20
Powdered skimmed milk	5.5	5.5	5.5	5.5
Honey	3	3	3	3
Baking powder	0.5	0.5	0.5	0.5
Baking soda	0.5	0.5	0.5	0.5
Flavoured (vanillin + cinnamon)	0.5	0.5	0.5	0.5

\*Composite flour is mixed in equal ratios of wheat, maize, rice, lentil, bean, chickpeas and kidneybean seeds

\*\*Addition in slurry form.

## Minerals

Minerals (Iron, manganese, calcium, magnesium, sodium, potassium and zinc) contents were determined by dry ashing according to the AOAC (2007) using an Atomic Absorption Spectrophotometer ( Model 2380,USA).

### Vitamin contents

The vitamins (ascorbic acid, riboflavin, niacin, folic acid,  $\beta$ -carotene and tocopherol) contents were determined by Reversed-phase HPLC using acetonitrile (polar solvent), dichloromethane(lower polarity) and methanol (hydrogen bonding capacity)solvents as a typical NARP mobile phase. The vitamins were separated on the Acclaim® Polar Advantage (PA) II column with a single injection using an aqueous-to non-aqueous mobile phase gradient. The HPLC columns—Acclaim PA, PA2, and C18—were used for the separations with an aqueous mobile phase (phosphate buffer-  $\text{CH}_3\text{CN}$ ) for water-soluble vitamins and a non-aqueous mobile phase ( $\text{CH}_3\text{OH}-\text{CH}_3\text{CN}$ -methyl tert-butyl ether) for fat-soluble vitamins. Detection wavelength-switching mode was applied for sensitivity optimization (Moreno & Salvado, 2000).

### Analysis of antinutritional factors

Trypsin inhibitor was extracted and determined using Lin & Chen (1989 ) method. Phytic acid was determined according to Wheeler & Ferrel (1971).

Haemagglutinin determination was by spectrophotometric method as described by Onwuka (2005).Alkaloids and oxalate were analyzed according to the AOAC (2007).

### Protein digestibility

Protein digestibility was determined using enzymatic hydrolysis (pepsin and pancreatin),then the nitrogen contents were analyzed by the micro-Kjeldahl method. The protein digestibility of samples were calculated by subtracting undigested protein from crude protein of the blends (Prakash & Prakash,1999).

### Acrylamide (AA) analysis

One hundred g of each sample were finely pulverized, homogenized and dehydrated at  $103^\circ\text{C}$  for 4 hour, prior to sampling. Solid samples 2 g each were accurately weighed into centrifuge tubes. A volume of  $10\ \mu\text{l}$  of the internal standard solution, Acrylamide at  $100\ \mu\text{g}/\text{mL}$ , was added to one centrifuge tube for recovery study. Eight ml of water

was used to extract acrylamide from blends and centrifuged for 15 min at  $3100 \times g$ . The aqueous phase was collected and the extraction process was repeated twice. The supernatant was mixed with 1 ml of a  $0.355\ \text{mol}/\text{l}$  potassium hexacyanoferrate (II) trihydrate solution (Carrez I) and 1 mL of a  $1.04\ \text{mol}/\text{l}$  zinc sulphateheptahydrate solution (Carrez II) and refrigerated for 30 min, then centrifuged. The extract were concentrated to 1 mL by evaporation under vacuum at  $45^\circ\text{C}$  kept in dark glass vials at  $4^\circ\text{C}$  until injection. The acrylamide determination was carried out using HPLC-UV instrument. An isocratic elution was performed at a flow rate of  $0.5\ \text{ml}/\text{min}$ , the mobile phase consisted of water/acetonitrile 96:4 (v/v),the retention time of AA was 10.1 min, and the total run time was 35 min. AA was detected by PAD detector ( 200.5 and 210 nm), at room temperature.. Under these chromatographic conditions, AA and the food components in the samples were all separated and eluted. The AA content is resulting from an average of three measurements and the relative standard deviation of each sample was below 10% (Kapeiet *al.*,2015).

### Statistical Analysis

The analysis of variance of the results was performed according to Steel & Torrie (1980). Statistical analysis was carried out by ANOVA and LSD procedure. The analysis was computed using the SpSS11.5 program.

## RESULTS AND DISCUSSION

### Sensory properties

The data presented in Table (2) revealed that all formulated samples were significantly ( $P \leq 0.05$ ) accepted for all the sensory properties. The best blend was that contained dates slurry, while blend containing nuts exhibited superior significantly ( $P \leq 0.05$ ) colour and overall acceptability. On the other hand, blend containing wheat bran was significantly ( $P \leq 0.05$ ) superior in taste and odour. However the texture of both blends had the same record. Finally, the control sample recorded significantly ( $P \leq 0.05$ ) lower acceptability comparing with the other samples.

### Chemical composition

Chemical composition of breakfast cereal – legume blends are shown in Table (3). The moisture content ranged from 12.95% in wheat bran blend to 16.67% in dates blend. The samples generally had low moisture content which implied that

**Table 2: Sensory properties of the breakfast cereal –legume blends**

Properties	Blends			
	Control	Dates	Nuts	Wheat bran
Colour	7.40 ± 1.03 <sup>b</sup>	8.30 ± 0.64 <sup>a</sup>	7.70 ± 0.69 <sup>b</sup>	7.60 ± 1.25 <sup>b</sup>
Taste	6.70 ± 1.56 <sup>a</sup>	7.00 ± 1.55 <sup>a</sup>	6.60 ± 2.17 <sup>a</sup>	6.80 ± 2.71 <sup>a</sup>
Odour	7.00 ± 1.26 <sup>a</sup>	7.30 ± 1.10 <sup>a</sup>	6.90 ± 1.62 <sup>a</sup>	7.20 ± 1.89 <sup>a</sup>
Texture	6.90 ± 1.45 <sup>a</sup>	7.20 ± 1.21 <sup>a</sup>	7.00 ± 1.51 <sup>a</sup>	7.00 ± 1.92 <sup>a</sup>
Overall acceptability	6.80 ± 1.10 <sup>b</sup>	7.40 ± 0.92 <sup>b</sup>	7.70 ± 0.92 <sup>a</sup>	7.30 ± 1.37 <sup>b</sup>

Values followed by the same letter in a row are not significantly different at  $P \leq 0.05$ .

the samples could have an extended shelf life in their raw form, since the moisture content of a food affects its stability and overall quality. The crude protein content ranged from 7.71% to 13.06% and the significantly highest content was for the nuts blend while the significantly lowest content was for the control one. The protein content of the samples was higher than that of a popular breakfast cereal in Nigeria, which has been reported to contain 10.92% crude protein. Samuel & Otegbayo (2006) reported that ogi (a popular breakfast cereal in Nigeria) fortified with 14.16% protein from soya bean plays a part in the organoleptic properties of the sample in addition to being a source of amino acids.

The crude ether extract content ranged from 4.48% in the control blend to 7.99% in nuts one. The range of crude fat detected was within the range of 13.37 to 21.50% as reported by Okafor & Usman (2013).

The ash content ranged from 2.30 % to 2.52%. The significantly ( $P \leq 0.05$ ) highest ash content was found in the nuts blend. These value are comparable to the value of 1.97 to 2.05 reported by Okafor & Usman (2013).

The carbohydrate content ranged from 62.84% in nuts blend to 71.80% in the control. The higher carbohydrate values recorded by other researchers may be attributed to the high content of the cereals and legumes used as the principal ingredients in the formulations (Kanu *et al.*, 2009).

The crude fiber content ranged from 3.19% to 3.98%. The significantly ( $P \leq 0.05$ ) highest content was traced for bran blend. McKeivith (2004) found that dietary fibers are important for the removal of waste from the body thereby preventing constipation and many health disorders.

The energy values were the lowest for the control blend and the highest for dates blend. Kent (1983) obtained similar caloric values for treated ready-to-eat breakfast cereal foods of energy value between 3 14.0 - 420.0 KcaV100g. The high energy content is advantageous for product formulation like breakfast cereals.

#### Mineral contents:

Table (4) shows the mineral contents of the different blends. These values are presented along with the corresponding values obtained from the

**Table 3: Chemical composition of the breakfast cereal –legume blends (on dry weight basis)**

Components	Blends			
	Control	Dates	Nuts	Wheat bran
Moisture	13.52 ± 0.22 <sup>b</sup>	16.67 ± 0.97 <sup>a</sup>	13.63 ± 0.21 <sup>b</sup>	12.95 ± 0.13 <sup>c</sup>
Crude protein (N ×6.25)	7.71 ± 0.07 <sup>d</sup>	8.73 ± 0.07 <sup>c</sup>	13.06 ± 0.16 <sup>a</sup>	9.67 ± 0.55 <sup>b</sup>
Crude ether extract	4.48 ± 0.21 <sup>d</sup>	5.08 ± 0.18 <sup>c</sup>	7.99 ± 0.11 <sup>a</sup>	7.44 ± 0.07 <sup>b</sup>
Ash	2.50 ± 0.40 <sup>a</sup>	2.30 ± 0.17 <sup>a</sup>	2.48 ± 0.39 <sup>a</sup>	2.52 ± 0.39 <sup>a</sup>
Carbohydrate*	71.80 ± 0.42 <sup>a</sup>	67.22 ± 0.21 <sup>ba</sup>	62.84 ± 0.60 <sup>c</sup>	67.42 ± 0.25 <sup>ba</sup>
Crude fiber	3.19 ± 0.75 <sup>a</sup>	3.93 ± 0.04 <sup>a</sup>	3.73 ± 0.05 <sup>a</sup>	3.98 ± 0.86 <sup>a</sup>
Energy value(Kcal \100g)	358.36 ± 16.92 <sup>a</sup>	375.71 ± 16.81 <sup>a</sup>	375.51 ± 2.9 <sup>a</sup>	375.32 ± 1.78 <sup>a</sup>

Calculated by difference

Values followed by the same letter in a row are not significantly different at  $P \leq 0.05$ .

**Table 4: Mineral contents of the breakfast cereal–legume blends (mg/100g) on dry weight basis**

Elements	Blends				USRAD*
	Control	Dates	Nuts	Wheat bran	
Fe	4.93	4.73	3.55	4.01	10-15
Zn	8.71	9.38	8.60	8.73	12-15
Mn	0.89	0.85	1.12	1.63	2-5
Ca	641.19	532.82	429.55	457.78	1000
Mg	91.93	94.80	93.20	91.33	280-350
Na	24.86	24.66	29.35	39.17	500
K	5.53	5.21	5.40	4.94	3.5

\*USRAD United States Recommended Dietary Allowance day (mg/kg body weight/day).

control sample. The iron and calcium contents of the blends ranged from 3.55 to 4.93mg/100g and 429.55 to 641.19mg/100g, respectively. The highest value was found in the control blend and the lowest was found in the nuts blend. The values of iron contents are lower than the values recommended by United States Recommended Dietary Allowance (USRDA) being 10-15mg/100g. The results presented here exhibited that each 100g of the formulated samples can provide about 35.50 - 32.87% of the USRDA requirement of iron. On the other hand, the values of calcium contents represent about 42.96% to 64.12% of USRDA requirements (1000mg/100g).

Manganese and sodium contents ranged from 0.85mg/100g to 1.63mg/100g and 24.66mg/100g to 39.17mg/100g, respectively. The highest value was found in wheat bran blend while the lowest value in dates blend. The manganese contents in blends represented 32.60% to 42.50% of USRDA requirement (2-5mg/100g). Moreover, the sodium values were far less than the required value recorded by the USRDA (500mg/100g).

Zinc content ranged from 8.60mg/100g to 9.38mg/100 g, magnesium contents ranged from 91.33 to 94.80mg/100g and potassium contents in the formulated blends ranged from 4.94mg/100g to 5.53mg/100g. The values of these three elements (zinc, magnesium and potassium) showed trace different in the four formulated blends. The values of zinc were lower than USRDA range (12-15mg/100g), consequently, each 100g of the formulated samples can provide about 62.53% to 71.67% of the USRDA requirement of zinc. Also, the magnesium contents in blends represented

27.08% to 32.62% of USRDA requirement (280 - 350mg/100g). Finally, the potassium limits in the blends were more than the USRDA requirements (3.5mg/100g) being higher by about 62.29 to 70.85 folds. In accordance with the results obtained in the present study, higher potassium values (70.19±6.82mg/kg) were recorded for fortified breakfast cereals (Usman, 2012).

#### Vitamin contents

Table (5) shows the water and fat soluble vitamin contents of the breakfast cereal –legume blends. The results revealed that the products contained high values of ascorbic acid (5.68 – 7.68mg/100g),  $\beta$ -carotene (3.91-6.16mg/100g), tocopherol (4.24-5.63mg/100g) and niacin (3.94 -4.64mg/100g) contents and low values of riboflavin (1.46 -1.86mg/100g) and folic acid (0.487 -0.585mg/100g) contents. Generally, the results showed that vitamins content in breakfast cereal can be improved through supplementation with blends of cereal and legume flour beside almond, dates or wheat bran. In the present study, the wheat bran breakfast cereal-legume blend was the lowest in ascorbic acid, riboflavin, niacin, folic acid and  $\beta$ -carotene contents. On the other hand, the results showed that the nuts blend was the highest in riboflavin, niacin and folic acid and tocopherol contents. Meanwhile, the control blend was the lowest in the tocopherol content and the dates blend was the highest in  $\beta$ -carotene content.

The whole-grain wheat breakfast cereal showed a lower total vitamin E content (796.90 ± 33.72 $\mu$ g/100g) than in whole grain sorghum breakfast cereal (3727.50± 352.0 $\mu$ g/100g) as found by Anunciação, *et al.* (2017). Banu, *et al.* (2012)

**Table 5: Water and fat soluble vitamin contents of the breakfast cereal –legume blends (mg/100g) on dry weight basis**

Vitamins	Blends			
	Control	Dates	Nuts	Wheat bran
Ascorbic acid (C)	6.20	7.68	6.06	5.68
Riboflavin (B <sub>2</sub> )	1.50	1.64	1.68	1.46
Niacin (B <sub>3</sub> )	4.24	4.55	4.64	3.94
Folic acid ( B <sub>9</sub> )	0.504	0.583	0.585	0.487
β-carotene	4.80	6.16	5.15	3.91
Tocopherol (E)	4.24	5.15	5.63	4.29

found that riboflavin content ranged from 8.7 to 21.6µg/100gm in mixture made from different cereals, legumes, millets, nuts. Meanwhile, Usman, (2012) showed that the B2 vitamin content of the breakfast cereal products ranged from 0.32±0.10 to 0.43±0.02mg/100g, and were lower than the recorded values for the control (1.08mg/100g) and the US RDA requirement (1.70mg/kg), while vitamin C content of the formulated samples ranged from 1.70±0.02 to 2.65±0.02mg/100g. These values are lower than the US RDA for men, women and children (30-60mg/kg).

#### Anti-nutritional factors

Anti-nutritional factors contents of the blends are presented in Table (6). The mean trypsin inhibitors activity values ranged between 13.61 to 24.71TIU/mg. The significantly highest value was in wheat bran blend and the significantly lowest value in the dates one. Ojo, *et al.* (2014) showed that elimination or inactivation of trypsin inhibitors by processing is necessary to improve nutritional quality and effectively utilize its full potential as human food. So that process like soaking and roasting in preparation of legume- cereal breakfast products were effective to reduce trypsin inhibitor in products as compared with its original content in legumes.

Phytic acid level of the blends ranged between 129.10 to 220.77mg/100g where the wheat bran blend had significantly the highest level whereas, the dates blend had significantly the lowest level. On the other hand, nuts blend and the control one had 176.24mg/100g and 210.50 mg/100g, respectively. Onyango *et al.* (2012) showed that the phytate content of instant control (untreated grains) breakfast cereals from optimized flours of pear millet, red and white sorghum ranged from 183.50 mg/100g to 185.32mg/100g.

Haemagglutinin (lectins) activities in legume-cereal breakfast blends ranged from 128.59 to 284.50 U/100g. At the same manner, the wheat bran blend had the significantly highest level and the dates blend had the significantly lowest level. On the other hand, nuts blend and the control one had 167.06 and 240.65U/100g, respectively. Pre-processing treatments (soaking, cooking and roasting) of cereals and legumes removed the toxicity effect of lectins (Jain *et al.*, 2009).

The alkaloids of legume-cereal breakfast blends ranged from 64.69 to 183.33mg/100g, where the significantly highest contain were recorded in dates blend while the significantly lowest was found in the control. Moreover, nuts and wheat bran blends recorded 82.93 and 116.66mg/100g, respectively. The alkaloid content of the seeds flours examined (Pear seeds and Watermelon seeds flours) were 10.14% and 15.34%, respectively (Olorode Omobolanue *et al.*, 2014).

Oxalate content of the blends under investigation ranged from 19.77mg/100g to 88.93mg/100g. Oxalate content of dates blend was significantly the lowest while the wheat bran blend had the significantly highest content. Usman *et al.* (2015) reported that the oxalate content of breakfast cereal blends made from rice, soybean and defatted coconut flours ranged from 0.077mg/g to 1.47mg/g. The protein digestibility of these blends ranged from 83.20 % to 90.11 %. The significantly lowest percent was in wheat bran blend while the significantly highest percent was in dates blend. Onyango *et al.* (2012) found that the percent of protein digestibility were 87.67%, 91.14 % and 92.90% in developed (alkali treatment, malting, fermentation and with protein complementation with pigeon peas) red sorghum, and white sorghum breakfast cereal products, respectively.

**Table 6: Anti-nutritional factors and Protein digestibility of the breakfast cereal –legume blends on dry weight basis.**

Factors	Blends			
	Control	Dates	Nuts	Wheat bran
Trypsin inhibitor (TIU/ mg)	20.31± 0.76 b	13.61± 1.07 d	17.18±0.90 c	24.71± 1.36 a
Phytic acid (mg/ 100g)	210.50± 3.47 b	129.10± 3.12 d	176.24±1.83 c	220.77±3.05 a
Haemagglutinin Activities (U/ 100g)	240.65± 2.33 b	128.59± 3.05 d	167.06±3.82 c	284.50± 2.37 a
Alkaloids (mg/100g)	64.69± 1.74 d	183.33± 2.42a	82.93±2.05 c	116.66± 1.65b
Oxalates (mg/ 100g)	30.82± 0.85 c	19.77± 1.15 d	53.78±1.34 b	88.93± 1.65 a
Protein digestibility (%)	88.08±0.22 b	90.11± 0.28 a	86.19± 0.46 c	83.20± 0.36 d

Values followed by the same letter in a row are not significantly different at  $P \leq 0.05$ .

### Acrylamide analysis (AA)

As shown in Fig. (2), the acrylamide contents in the breakfast cereal blends formulated in the present study varied from 281.18 $\mu\text{g}/\text{kg}$  to 363.00  $\mu\text{g}/\text{kg}$ . The significantly ( $P \leq 0.05$ ) highest level was in dates blend and the lowest level was in the control one, while the intermediate levels were in both of the bran and the nuts blends. Acrylamide content was determined in maize, wheat, rice, sorghum pearl millet, soybean and chickpea which used in preparing cereal and legume based food products. The highest value was in maize (2195.31  $\mu\text{g}/\text{kg}$ ) and the lowest value was in wheat (161.12 $\mu\text{g}/\text{kg}$ ). Meanwhile the intermediate values were in the other cereals and legumes (Galani *et al.*, 2017).

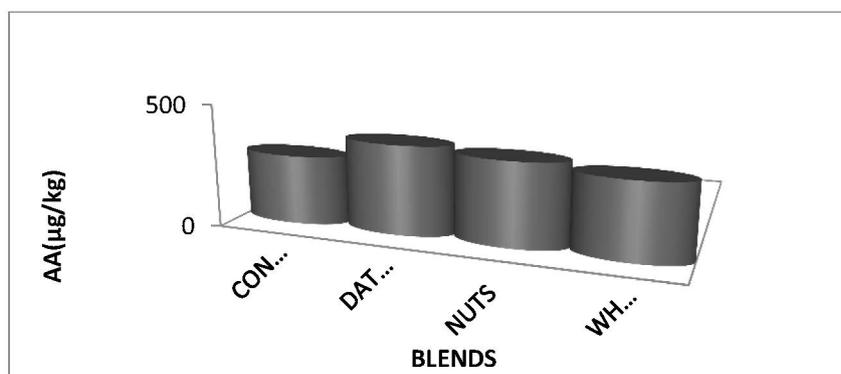
### CONCLUSION

The present study has shown that nutritious breakfast cereal can be produced from blends of local seven seeds such as wheat, maize, rice, lentil, bean, chickpeas and kidney beans. The results obtained show that all formulated samples were found

to be satisfied acceptable, high in protein contents (7.71% to 13.06 %), ether extract (4.48% to 7.99%) and ash content (2.30% to 2.52%). Moreover, these blends were high in minerals such as calcium and magnesium and vitamin B. Therefore, these breakfast cereal- legume blends products can be used by both adults and children alike because they are considered to be healthier types of ready to eat foods.

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**Fig. 2** Acrylamide contents of breakfast cereal- legume blends ( $\mu\text{g}/\text{kg}$  sample)

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## توليف وتقويم بعض خلطات الإفطار الجديد المصنعه من الحبوب و البقوليات

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تم تحضير أربع خلطات إفطار من مخلوط الحبوب مع البقول عن طريق خلط الدقيق (القمح والذرة والأرز والعدس والفاصوليا) مع اللوز والتمروردة القمح، بالإضافة إلى إضافات أخرى مثل مسحوق الحليب منزوع الدسم والعسل ومسحوق الخبيز، صودا الخبيز ونكهة (الفانيليا + القرفة). تم جلته نشا الحبوب والبقول بواسطة التحميص للحصول على منتجات إفطار جاهزة للأكل. وقد تم عمل تقييم حسي و تقدير التركيب كيميائي وتقدير للمعادن وللفيتامينات ومضادات التغذية وتحليل الأكريلاميد للخلطات الثلاث بالإضافة إلى الكنترول. و تم التقييم الحسي للمنتجات التي تم الحصول عليها جافة مع الحليب الدافئ بواسطة عشرة محكمين جنبا إلى جنب مع تقييم اللون والطعم والرائحة والملمس وقبولها بشكل عام باستخدام مقياس يتكون من ١٠ نقاط. وأظهرت النتائج ان التركيب الكيماوي كنسبة مئوية (%) كان على النحو التالي: الرطوبة (١٢,٩٥ - ١٦,٦٧)، البروتين (٧,٧١ - ١٣,٠٦)، مستخلص الإثير الخام (٤,٤٨ - ٧,٩٩)، الرماد (٢,٣٠ - ٢,٥٢)، الكربوهيدرات (٦٢,٨٤ - ٧١,٨٠) (٣,٩٨ - ٣,١٣) والطاقة (٣٥٨,٣٦ كالوري - ٣٧٥,٧١ كالوري). وأظهر تحليل المعادن قيما في المدى التالي للخلطات الاربع التي تم إعدادها (ملجم / ١٠٠ جم): الحديد (٣,٥٥ - ٤,٩٣)، الزنك (٨,٦٠ - ٩,٣٨)، المنجنيز (٠,٨٥ - ١,٦٣)، الكالسيوم (٤٢٩,٥٥ - ٤٦١,١٩)، المغنيسيوم (٩١,٣٣ - ٩٤,٨٠)، الصوديوم (٢٤,٦٦ - ٣٩,١٧) والبوتاسيوم (٤,٩٤ - ٥,٥٣). كما أظهرت نتائج تحليل الفيتامينات مقدره كملجم / ١٠٠ جم ما يلي: حمض الأسكوربيك (٥,٦٨ - ٧,٦٨)، ب ٢ (١,٤٦ - ١,٦٨)، ب ٣ (٣,٩٤ - ٤,٦٤)، ب ٩ (٠,٤٨٧ - ٠,٥٨٥)، بيتا- كاروتين (٣,٩١ - ٦,١٦) وفيتامين E (٤,٢٤ - ٥,٦٣). أظهرت نتائج مضادات التغذية القيم التالية: مثبط التريسين (١٣,٦١ - ٢٤,٧١) وحدة مثبط تريسين / ١٠٠ جم) وحمض الفيتيك (١٢٩,١٠ ملجم / ١٠٠ جم - ٢٢٠,٧٧ ملجم / ١٠٠ جم)، ونشاط مسببات التجلط (١٢٨,٥٩ وحدة / ١٠٠ جم - ٢٨٤,٥٠ وحدة / ١٠٠ جم)، ألقويدات (٦٤,٦٩ ملجم / ١٠٠ جم - ١٨٣,٣٣ ملجم / ١٠٠ جم)، حمض الأوكساليك (١٩,٧٧ ملجم / ١٠٠ جم - ٨٨,٩٣ ملجم / ١٠٠ جم) و هضمية البروتين (٨٣,٢٠ - ٩٠,١١)%. كما تراوح محتوى الأكريلاميد في الخلطات الأربع من ٢٨١,١٨ ميكروجرام / كجم إلى ٣٦٣ ميكروجرام / كجم.