

Producing Biscuits Enriched with Carotene and Iron According to the Nutritional Status Assessment of Primary School Girls in Arar, Saudi Arabia

Amani A. A. Sallou¹, and Abd Elaziz F.A. Ashry²

ABSTRACT

The present study was carried out to assess the nutritional status of a sample of primary school girls and preparing biscuits enriched with carotene and iron by using carrot powder and replacing sugar by black strap molasses as source of iron.

A sample consisted of 132 school girls in Arar region, Saudi Arabia. Data were collected from the children and recorded using 24-hour recall for three following days to obtain detailed information about consumed food and beverages. The anthropometric measurements of children were included the weight (kg), height (cm), waist circumference (cm), mid arm circumference (cm), triceps skinfold thickness (mm), upper arm muscle area, body mass index (kg/m²). Laboratory analysis for hair and nails samples were done to determinate their iron content .

The results showed that mean energy, protein and calcium intakes were 66.5%, 109.82%, and 39.86% of RDA, also, the mean intake of iron was 62.2% of RDA. While the mean intakes of vitamin A and vitamin C were 74.8 % and 95.9% of RDA, respectively. The mean values of weight, height, and body mass index were 41.3(kg), 144.5(cm) 19.6(kg/m²), respectively. The mean values of iron in hair and nails were 1.92 ppm and 1.18 ppm, respectively .

Based on the results of the assessment of nutritional status, biscuit from wheat flour supplemented with 10% carrot powder and replacement sugar by black strap molasses was prepared. It was acceptable and each 100g provided 4.8mg iron, and 1666.67IU of vitamin A compared to 1.4 mg and null of vitamin A in the control biscuit.

Key words: Nutritional status, anthropometric measurements, iron, hair, and nails

INTRODUCTION

It is important for children to learn how to eat a healthy and varied diets that provide all nutrients required for growth and health status. (Michael, 2015).

The physical growth of children is reflected by different anthropometric measurements especially weight and height. The physical dimensions of the body are much influenced by nutrition in growing period of school age. Poor health and nutritional status will affect work capacity as well as cognitive functions, and this age is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes (Manna *et al.*, 2011). Anthropometry is widely recognized as one of the useful techniques to assess the

growth and nutritional status of individual or population (Margaret *et al.*, 2005; WHO, 2006).

A child's weight, height and age permit determination of degree of underweight, stunting or wasting and such measures are usually considered as proxies of protein energy malnutrition. The regular monitoring of child growth is one of the major concerns for the public health policy makers and planners (El-Sayed and Agamy , 2013; Grover *et al.*, 2009).

Hair, teeth, and nails can accumulate not only toxic metals such as Pb and Cd but also essential metals such as Zn, Cr, Fe, Ni, Co, Cu, Mn, Ca, Na, and K (Nowak and Chmielnicka, 2000). Various biological materials such as hair, human milk, blood, urine and nails have been used to assess trace element level in the human body (Sauad *et al.*, 2006 ; Dongarrà, 2012).

Vitamin A or carotenoids (provitamin A) required for growth, development and physiological functions, as well as in prevention of blindness (Sommer, 1995 ; Wolf, 2001).

Pro-vitamin A (carotenoids) are a major source of dietary vitamin A in a large proportion of the world population and β -carotene (β c) is the most common provitamin A carotenoids (Solomons, 2001). Iron is an essential component of hemoglobin, the oxygen transporting protein blood (Robert, 2018).

Iron deficiency anemia appeared to be prevalent among Saudi school students. At age 12 years and over, low social class and menstruating girls showed high-risk groups (Abalkhail and Shawky, 2002).

Evidence has been mounting to suggest a relationship between vitamin A and iron metabolism (Marcela *et al.*, 2014). The potential important of such an interaction was recognized nearly four decades ago when iron deficiency anemia was reported to develop in vitamin A deficient adults (Hodges *et al.*, 1978).

A major advantage of using biscuit as a carrier for micronutrients and as a snack, it is also easy to offer, no preparation, long self-life (Asal, 2004).

The present investigation was undertaken with the objectives to assessment of nutritional status of a sample of school girls and producing biscuits enriched with provitamin A and iron by using carrot powder and black strap molasses as a source of iron.

¹ Dept. of Home Economics, Faculty of Specific Education, Mansoura University

² Dept. of Nutrition and Food Science, Faculty of Home Economics, Northern Border University (KSA)

MATERIALS AND METHODS

a- Nutritional Status of Children: -

The studied subjects consisted of 132 school girls from Arar region, Saudi Arabia. Data were collected from the children and recorded using 24-hour recall for three following days to obtain detailed information of consumed foods and beverages. The daily data were analyzed using the food composition tables (National Nutrition Institute, 2006) to estimate the nutrients content of the daily diet. Daily intake were compared with the recommended dietary allowance (RDA) published by (FAO&WHO ,2006).

The anthropometric measurements of children were taken as described by (Gibson, 2005). The weight (kg), the height (cm), waist circumference (cm), mid arm circumference(cm), triceps skinfold thickness (mm), upper arm muscle area and body mass index (Kg/M²) measurements were compared with NCHS standards (Fryar *et al.*, 2012).

Hair and nails samples were obtained from each child under investigation using acid washed scissors. A sample of approximately 5 cms proximal to the occipital region of the head was taken and the sample of nails was taken also and each one of them prepared for analysis after washing in hexane, ethanol and demonized water according to G.O.A.E.F (1996).Samples were ashed according to the method of A.O.A.C. (2000).

The ashes samples were dissolved in 10% hydrochloric acid and by using Atomic Absorption Spectroscopy. The iron content was measured According to (Luten *et al.*, (1996).

b- Fortified biscuits :

- Ingredients of biscuits

Wheat flour (72% extraction), carrots, black strap molasses, sugar, salt, vanillin, baking powder and vegetable shortening were obtained from Arar local market.

- Preparation of Carrots powder

Yellow carrots were cleaned and washed with distilled water, peeled, and cut into slices, the slice materials were soaked in boiling water for 15 min then cooled with distilled water and dried in an air oven dryer (40-50°C) for 24 hr, finally milled in order to pass through 30 mesh sieve according to (Mahagoub ,2008).

- Preparation of biscuits:

Control biscuits sample was prepared included 100 g of ingredient with baking powder 3g, milk 26 ml, shortening 20g, salt 1g and sugar 40g according to the method described by Abdel-Magied (1991). The supplemented biscuits were prepared using the same formula expect for replacement sugar with blackstrap molasses and wheat flour (72%) with carrot flour at 5,10 and 15 % (Table 1). All different biscuits formula were

baked at 230 °C for 10-15 min then cooled and packaged in poly ethylene bags for further investigation.

Table 1. Biscuits formula from wheat flour, carrot powder

| Samples Ingredients (%) | Control | 1 | 2 | 3 |
|----------------------------|---------|----|----|----|
| Wheat flour (w.f) | 100 | 95 | 90 | 85 |
| Carrot powder | - | 5 | 10 | 15 |

Organoleptic evaluation of biscuits:

Biscuits samples were evaluated organoleptically by a panel of ten panelists for appearance,color, thickness, crispiness, shrinkage, taste and odor as the method described by Smith (1972). The scores are shown in Table (2).

Table 2. Organoleptic evaluation of the prepared biscuits

| characteristics | Score |
|-----------------|-------|
| Appearance | 10 |
| Color | 15 |
| Thickness | 15 |
| Crispiness | 15 |
| Shrinkage | 15 |
| Taste | 15 |
| Odor | 15 |
| total | 100 |

- Chemical analysis:

The moisture content, crude fiber, crude protein, crude fat, and ash were determined according to the method of A.O.A.C. (2000). Total carbohydrate content was calculated by difference.

-Determination of iron: -

Samples were ashed according to the method of A.O.A.C. (2000), the ashed samples were dissolved in 10% hydrochloric acid and by using Atomic Absorption Spectrometry (pyeunicm Model 3300) at 422 nm and the iron sample was measured According to Luten *et al.*, (1996), at Micro Analytical Unit, Faculty of Science, Mansoura University.

- Determination of (vitamin A):-

Vitamin A was determined according to Neeld and Pearson (1963). At Principal Central Lab, Faculty of Agriculture, Cairo University.

Statistical analyses were processed by IBM- PC computer using SPSS software program 2000. Mean and standard deviation (SD) were calculated for the majority of variables. Qualitative variables expressed as percentage were compared to different groups. T test was also used to know if there were any significant differences between two groups

RESULTS AND DISCUSSION

a- Nutritional Status of Children:-

The data in Table (3) show the distribution of children according to age. As shown, the age of 56.1% of the children was 12 years, while the children at 9 years and 10 years were 12.12%, and 13.63%, respectively.

Regarding to father education, it is clear that more than half of fathers (57.6%) had Secondary school grades, while less than half of the mothers (45.5%) could read and write. On the other hand, 3.03% of fathers versus 9.1 % of mothers had University degree. Nour *et al.*, (2013) found that lack of education resulted of poor food selection and poor life.

It noticed that the high level of school attendance was (75.8%) of the studied sample, while the moderate level presented (24.2%).

As shown from Table (3) the school achievement of the studied sample was at moderate level for (51.5%), while the high level for achievement was (45.5%), and only (3%) of the girls had low school achievement.

Eating Habits: -

Eat Breakfast: -

Many studies found that breakfast helps children to learn better in school, improves their appetites and general health. Only about one fifth of the sample always taken breakfast (Table: 4), while one third of them skipped the breakfast. These results are in agreement with the result found by Manal (1997).

Take sandwiches: -

At the same Table (4), it is clear that (15.2%) of the school girls rarely taken sandwiches, while who sometimes taken sandwiches were (45.5%), but who always take sandwiches were (39.4%).

Eat sandwiches - :

Regarding eating sandwiches, as shown from Table (4), it could be noticed that (45.5%) sometimes ate sandwiches, while (21.2% and 33.3%) rarely and always ate sandwiches, respectively.

Eat biscuits:-

As shown from Table (4), the percentage of girls who always eating biscuits was (66.7%).It was higher than sometimes and rarely (18.2% and 15.13%), respectively.

Table 3. Demographic characteristics of children of their families

| n=(132) | | |
|--------------------------------------|-----|------|
| Characteristics | No | % |
| Age categories | | |
| 9 years | 16 | 12.1 |
| 10 years | 18 | 13.6 |
| 11 years | 24 | 18.2 |
| 12 years | 74 | 56.1 |
| Educational level for fathers | | |
| Illiterate | 12 | 9.1 |
| Read and write | 16 | 12.1 |
| Primary | - | - |
| Preparatory | 24 | 18.2 |
| Secondary | 76 | 57.6 |
| University | 4 | 3.03 |
| Educational level for mothers | | |
| Illiterate | 20 | 15.2 |
| Read and write | 60 | 45.5 |
| Primary | 12 | 9.1 |
| Preparatory | 28 | 21.2 |
| Secondary | - | - |
| University | 12 | 9.1 |
| Attendance level for school | | |
| Low | - | - |
| Moderate | 32 | 24.2 |
| High | 100 | 75.8 |
| Level of achievement | | |
| Low | 4 | 3.0 |
| Moderate | 68 | 51.5 |
| High | 60 | 45.5 |

Table 4. Percentage distribution of primary school children according to some eating habits

| n=(132) | | | |
|-----------------|----|-------|--|
| Variables | No | % | |
| Eat Breakfast | | | |
| Rarely | 44 | 33.3 | |
| Sometimes | 60 | 45.5 | |
| Always | 28 | 21.2 | |
| Take Sandwiches | | | |
| Rarely | 20 | 15.2 | |
| Sometimes | 60 | 45.5 | |
| Always | 52 | 39.4 | |
| Eat Sandwiches | | | |
| Rarely | 28 | 21.2 | |
| Sometimes | 60 | 45.5 | |
| Always | 44 | 33.3 | |
| Eat Biscuits | | | |
| Rarely | 20 | 15.13 | |
| Sometimes | 24 | 18.2 | |
| Always | 88 | 66.7 | |

Nutrients intake compared to RDA (FAO&WHO ,2006):

Data tabulated in Table (5) revealed that mean energy, total protein and calcium intakes were 66.5%, 109.82%, and 39.86% of RDA, respectively. These results are in disagreement with those of WHO (1998), which demonstrated that 60% of Egyptian children in Cairo governorate got energy more than 75% of their RDA, while Nassef (1999) illustrated that 64.6% of the Egyptian students under study in six different governorates of Egypt had energy intakes over 90% of the recommended dietary allowances (RDA). But these

results agreed with Habib and El-Bagoury *et al.*, (1999) who found that the intakes of calcium were less than their RDA. At the same Table, the mean intake of animal iron was (39.86%) of RDA, these results at parallel with Farrag (2003) who found that 30% of the student girls (at Assiut governorate) took less than the recommended amounts of iron. In addition, the mean intakes of vitamin A and vitamin C were (74.8 % and 95.9%) of RDA, respectively. These results are less than those of Shabayek (2004) who observed that the intakes of vitamin C for students in Alexandria city was exceeded than the recommended amounts, of RDA (FAO&WHO ,2006).

Table 5. Mean and standard deviation of nutrients intake compared to RDA, (2006)

| Nutrients | N= (132) | | |
|---------------------|-----------|--------|--------|
| | Mean | ± SD | RDA% |
| Energy(kcal) | 1401.5 | 628.23 | 66.5 |
| Animal protein (gm) | 14.7 | 9.3 | - |
| Plant protein(gm) | 35.7 | 21.9 | - |
| Total protein(gm) | 50.5 | 22.09 | 109.82 |
| Animal fat(gm) | 14.02 | 12.9 | - |
| Plant fat(gm) | 32.87 | 21 | - |
| Total fat(gm) | 46.89 | 21.82 | - |
| Carbohydrate(gm) | 212.99 | 76.5 | - |
| Fiber(gm) | 14.49 | 8.8 | - |
| Calcium(mg) | 475.72 | 280.3 | 39.86 |
| Animal iron(mg) | 7.8 | 19.39 | - |
| Plant iron(mg) | 6.34 | 13.5 | - |
| Total iron(mg) | 15.67 | 7.96 | 62.2 |
| Vit A (IU) | 1490.8 | 603.06 | 74.8 |
| Vit C (µg) | 56.66 | 30.7 | 95.9 |

Body mass index;

Data in Table (6), revealed a high percentage of underweight (65.9%). These results are fit with those in Table (5) which shown that the studied sample consumed (66.5%) of energy less than those of RDA .While only (27.27%) of the sample had on acceptable BMI. On the other hand, overweight and sever overweight were among (6.81%) of the girls.

Table 6. Percentage distribution of school girls according to body mass index

| BMI | n=132 | % |
|----------------------------|-------|-------|
| (Less to15)under weight | 87 | 65.9 |
| 15-21.9 (Acceptable) | 36 | 27.27 |
| (22-24.9) Over weight | 5 | 3.78 |
| (25-32.9)sever over weight | 4 | 3.03 |
| (obese) More than33 | - | - |

(Jebb *et al.*, 2004)

Assessment of iron contents in children's from hair and nails among sample:

Data in Fig, (1) illustrate mean and standard deviation of iron contents in hair and nails of the studied samples. The mean values of iron in hair and nails were 1.92 µg/g and 1.18 µg/g, respectively. The results in agreement with those of Meng (1998). Abalkhail and Shawky (2002) found that iron deficiency anemia appeared to be prevalent among Saudi school students. At age 12 years and over, low social class and menstruating girls showed high-risk groups. Concerning the human nails as a marker of the body iron, Sobolewski *et al.*, (1978) found that the mean concentrations of iron in human nails were 12µg/g and 13µg/g for no anemic males and females, respectively, compared to less than 3µg/g for patients with iron deficiency. Sahin *et al.*, (2015) found that the mean hair iron concentrations of anemic group were measured as 5.08-6.03µg/g, compared to 12.01-17.62 µg/g for the control group. According to the results of the both studies of Sobolewski and Sahin, it is evident that our studied sample suffers from iron deficiency anemia. Therefore, it is important to provide food rich in iron and preferred for children such as biscuits.

Table 8. Iron and vitamin A content in biscuits made from wheat flour (72% extraction) and 10% carrot powder (on dry weight basis)

| Samples | Iron (mg /100g) | Vit. A (IU/100g) |
|-------------------------------|-----------------|------------------|
| 72% W.F | 1.40 | Nd |
| W.F (72% extract.) (molasses) | 5.40 | Nd |
| 90% W.F + 10% C.P (molasses) | 4.80 | 1666.67 |

W.F= Wheat flour, C.P= Carrot powder, nd = not detected

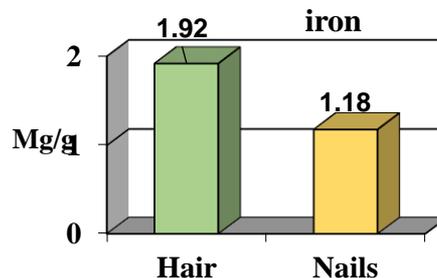


Fig.1. Mean of iron in children's hair and nails

b-Fortified biscuits :

Vitamin A content of raw materials used in biscuits formulation:-

Vitamin A content of carrot, (on dry weight basis) was shown in table (7). It could be noticed from the results that carrot powder had the highest level of vitamin A (29858.33 IU/100g), these result at accordance with Ally (2001).

Table 7. Vitamin A (IU/100g) content in Carrot powder (on dry weight basis)

| Ingredients | Vit. A (IU/100g) |
|---------------|------------------|
| Carrot powder | 29858.33 |

Iron and vitamin A content in biscuits made from wheat flour (72%) and (10% carrot powder):-

Iron content in biscuits formula from wheat flour and 10% carrot powder was tabulated in table (8), iron content of control biscuit samples with sugar was (1.40 mg/100gm) and with black strap molasses was (5.4 mg/100gm), on the other hand, iron content in biscuits formula from wheat flour and 10% carrot powder was 4.80 mg/100gm .

So, the addition of black strap molasses in bakery products especially processed biscuits with recommended formula increased the amount of iron besides the other cheap and local additives.

At the same table, data indicated that the high amount of vitamin A was 1666.67IU/100gm in the formula containing 75% wheat flour + 10% carrot powder.

Generally, from data presented in table (8), the addition of carrot powder, increased the amount of vitamin A for all biscuits formula processed from wheat flour (72%).

Data in table (9) showed the gross chemical composition of biscuits processed from wheat flour (72% and 10%) carrot powder ,Results indicated that moisture content ranged from 5.66 to 5.89% in biscuits formulae. All biscuits formulae were higher in moisture content. Results also, indicated that protein content of control formula was higher than those of the other mixtures. This could be due to that the ratio of additives namely carrot powder contained low amount of protein in comparing with wheat flour. The ash content in biscuit formula was increased slightly comparing with biscuit mixture.

Reviewing to the data in the same Table, the fiber content in biscuit processed from wheat flour mixtures was higher than of control sample. The increasing of fiber related to the addition of carrot powder, which covered a gradual increase in fiber content, Generally, these results are in agreement with those given by (Hussein, 2001).

From the same table, the results revealed that biscuit from wheat flour 72% extraction contain the highest amount value of carbohydrates (75.54%) from 10% carrot powder on dry weight basis These results are in agreement with those of Ghoniem, (2002).

The organoleptic properties of biscuits made from wheat flour (72%) with 10% carrot powder:-

Biscuit supplemented by 10% carrot powder and molasse were sensory evaluated for appearance, color, thickness, crispness, shrinkage, taste, odor and overall acceptability and compared with control biscuit as presented in Table (11).

Data presented in Table (10), show that formula contained 10% carrot powder had the least acceptability of the panelists (74.68).

Table 9. Chemical composition of biscuits

| Samples | Constituents | | | | | |
|---|---------------|-----------------|-----------------|---------------|---------------|---------|
| | Moisture % | Crude protein % | Crude fat % | Ash % | Crude fiber % | Carb. % |
| W.F 100% | 5.78 ±0.17 | 10.53 ±0.8 | 12.33 ±0.22 | 2.5 ±0.49 | ±0.13 0.34 | 70.38 |
| W.F 100% (molasses) | 5.66 ±0.67 | 8.77 ±0.32 | 13.33 ±0.2 2 | 2.10±1.40 | 0.50 ±0.23 | 75.3 |
| 90% W.F +10% carrot powder (molasses) | 5.89 ±0.56 | 8.51 ±0.43 | 13.00 ±0.43 | 2.41 ±1.43 | 0.54 ±0.22 | 75.54 |

Table 10. The organoleptic properties of biscuits

| Samples | Appearance (10) | Color (15) | Thickness (15) | Crispness (15) | Shrinkage (15) | Taste (15) | Odor (15) | Total (100) | Acceptability % |
|--------------------------------------|--------------------|---------------|-------------------|-------------------|-------------------|---------------|--------------|----------------|--------------------|
| W.F %100 (.72% extra | 8.98 | 13.12 | 11.5 | 12.32 | 12 | 12.25 | 12.5 | 83.67 | 100.0 |
| 100% W.F (72%extr.) (molasses) | 8.50 | 12.66 | 13.22 | 12.36 | 12.25 | 12.25 | 11.95 | 83.19 | 100.0 |
| 90% W.F +10% C.P (molasses) | 7.85 | 11.50 | 11.00 | 10.00 | 12.10 | 11.00 | 11.23 | 74.68 | 89.77 |

CONCLUSION

The assessment of the nutritional status of school children is consistently important to solve health problems early. Preferably strengthen biscuits with carrot powder and molasses, to increase the content of vitamin A and iron, which reduces anemia associated with iron

deficiency. Therefore, encourage future research for producing various types of foods containing fruit and vegetables that have beneficial health effects of school children, based on the study of the nutritional status .

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الملخص العربي

إنتاج البسكويت مدعم بالكاروتين والحديد وفقاً لتقييم الحالة التغذوية للفتيات في المرحلة الابتدائية بعمر بالمملكة العربية السعودية

اماني احمد عبد القادر سلو و عبد العزيز فتحي عبد العزيز عشري

أوضحت النتائج أن متوسط الطاقة و البروتين والكالسيوم المتناول بلغت كانت ٦٦,٥% و ١٠٩,٨٢% و ٣٩,٨٦% من الـ RDA ، كما أن متوسط استهلاك الحديد الكلي كان ٦٢,٢% من الـ RDA. بينما كان متوسط مدخول فيتامين (أ) وفيتامين (ج) ٧٤,٨% و ٩٥,٩% من الـ RDA على التوالي. وكانت القيم المتوسطة للوزن ومؤشر كتلة الجسم ومحيط الخصر ٤١,٣ (كجم)، ١٩,٦ (كجم / م ٢) و ٧٥,٨ (سم) ، على التوالي. بينما كان متوسط الطول ١٤٤,٥ (سم). وكانت القيم المتوسطة للحديد في الشعر والأظافر ١,٩٢ جزء في المليون و ١,١٨ جزء في المليون، على التوالي.

بناء على نتائج تقييم الحالة التغذوية ، تم إعداد بسكويت من دقيق القمح مع ١٠% مسحوق الجزر واستبدال السكر العسل الأسود.

أجريت هذه الدراسة لتقييم الحالة التغذوية لعينة من الفتيات في المدارس الابتدائية وإعداد البسكويت الغني بالكاروتين والحديد باستخدام مسحوق الجزر واستبدال السكر بالعسل الأسود كمصدر للحديد. العينة تتكون من (١٣٢) فتاة في منطقة عرعر، المملكة العربية السعودية. تم جمع البيانات من الأطفال وتسجيلها باستخدام استدعاء ٢٤ ساعة لمدة ثلاثة أيام بعد الحصول على معلومات مفصلة عن الأغذية والمشروبات المستهلكة. تم استخدام القياسات الأنثروبومترية للأطفال من خلال الوزن (كجم)، الطول (سم)، محيط الخصر (سم) ، محيط منتصف الذراع (سم)، سمك ثلاثية الرؤوس للجلد (mm) ، منطقة عضلات الذراع العلوية، مؤشر كتلة الجسم (kg / M^2). تم إجراء التحاليل المخبرية لعينات الشعر والأظافر لتحديد محتواهما من الحديد.