FORTIFICATION OF SOME TYPES OF BISCUITS WITH IRON – RICH PLANT ADDITIVES

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Abstract

This study has been under taken a trial to produce dry biscuits and date biscuits fortified with plants rich in iron (Thyme, karkade, chichory leaves and purslane) as functional foods to treat iron deficiency anemia. Edible parts of (Thyme, karkade, chichory and purslane) were dried and ground, and their iron content was determined. Each powder of materials were used as a source of iron and mixed with siwi date to fill biscuits. Ferrous sulfate was used as a chemical control source of iron. Iron content was 5 mg/l00gm of products (on dry weight basis). Chemical composition, sensory evaluation and economic value of resultant products were studied. No significant differences between control and date biscuits fortified with iron sources in crumb and crust color, texture and mastication.

Significant differences ($P>0.05$) were found in date biscuits between thyme, purslane and control sample in taste. Dry biscuits fortified with thyme, karkade, chicory and purslane were acceptable in terms of odor, taste and texture compared with control sample. The cost of ingredients date biscuits increment percent of cost ranged from 3.8 in date biscuits fortified with chicory to 24.16% in date biscuits fortified with karkade.

INTRODUCTION

Anemia is the most common nutritional problem among Egyptian children and makes children weak as it affects the immune system. It causes fatigue rapidly and impacts on intellectual performance. Anemia of children reaches its peak between 12 and 23 months which is a critical period in the child's intellectual and physical development *(UNICEF, 1991)*.

Food fortification with iron is generally considered the most effective way to increase iron intake and can be achieved by fortifying a dietary staple such as cereal flour or by fortifying widely consumed foodstuffs such as sugar and salt. *(Hallberg, 1996).* Biscuits can be used successfully as a vehicle for nutrient fortification in school feeding programs.

Food used in school meal programs are excellent potential vehicles for targeted iron – fortification programs. This is particularly true in countries where the prevalence of childhood iron deficiency anemia is high *(Davidsson et al., 2001).*

Thyme is used to season salad croutons, fried chicken and prepared poultry stuffings. Its active oil ingredient, thymol, is an effective ingredient in cough drops, colognes, baked goods and canned soups *(Farrell, 1990).*

Hayashi and Seguchi (1998) were interested in blending karkade with wheat flour to make healthful, mineral - enriched bread. They concluded that bread produced with added karkade flour would help meet the nutritional requirements for Fe in the Japanese diet. *Kassim(2002)* and *Barkat(2003)* found the minerals especially Fe and Ca were high in karkade flour. The iron ranged from 113.39 to 151.43 mg/100g and the calcium ranged from 831.25 to 1503.4 mg/100g.

Chicory also known as coffeweed. Young chicory and escarole leaves, which have a slightly butter tang, are used in salads. The older leaves can be cooked and served like spinach (*Farrell, 1990).*

Leung and Foster (1996) reported that purslane is eaten as a salad and vegetable by people around the world, and is used medicinally for various conditions, including headache, stomach, painful urination, dysentery enteritis, mastitis and lack of milk flow in nursing mothers.

This research acts as a trial to produce biscuits fortified with natural iron using some plants rich in iron such as thyme, karkade, chicory and purslane, as compared with the common fortifier ferrous sulfate.

MATERIALS AND METHODS

Materials:

Thyme and karkade:

Thyme *(Thymus vulgaris L.)* and karkade *(Hibiscus sabdariffa)* were obtained from the local market.

Chicory Leaves and purslane plants:

Chicory *(Cichorium oleracl L.)* leaves and purslane (*Portulaca olertacea*) plants were collected from fields of Egyptian clover at El-Gharbiya province, Egypt.

Siwi dates:

Siwi dates variety at tamr stage were obtained from Abou Rawash region. Giza, Egypt.

Ferrous sulfate:

Ferrous sulfate (Fe So_4. 7H20) was obtained from El. Nasr pharmacerrtical chemical Co., Cairo, Egypt,

Wheat flour:

Wheat flour, 72% extraction was obtained from Flour Land Company, 6th of October City, Egypt.

Methods:

Preparation of thyme and karkade powders:

Thyme and karkade were ground and sieved through a 20 mesh sieve.

Preparation of dehydrated chicory and purslane samples:

Chicory leaves and purslane plants were washed and rinsed with tap water. Washed chicory leaves and purslane plants were dehydrated at 50C for, 36 hours. Dried chicory leaves and purslane plants were ground and sieved through a 20 mesh sieve.

Preparation of biscuits

The biscuits were formulated to contain 50% of the daily RDA (Recommended Dietary Allowances, 1989) of iron (5mg Fe) for children aged 1-10

years old. The composition of different types of biscuits fortified with different sources of iron are shown in Table (1) *A.A.C.C. (1980)*

Table 1. Formulation of control and fortified biscuits with different of iron (on fresh weight basis).

Ingredients (g)	Control	Biscuits prepared with				
		Ferrous sulfate	Thyme	Karkade	Chicory	Purslane
Wheat flour 72%	100	100	97.16	97.11	95.81	96.86
Ferrous sulfate	-	0.016	-	-	-	-
Thyme	-	-	2.84	-	-	-
Karkade	-	-	-	2.89	-	-
Chicory	-	-	-	-	4.19	-
Purslane	-	-	-	-	-	3.14
Sugar	36	36	36	36	36	36
Shortening	30	30	30	30	30	30
Na bicarbonate	0.75	0.75	0.75	0.75	0.75	0.75
Ammonium Bicarbonate	1	1	1	1	1	1
Skim milk	1.5	1.5	1.5	1.5	1.5	1.5
Vanilla	0.2	0.2	0.2	0.2	0.2	0.2
Water	22	22	22	22	22	22

These ingredients were mixed for 3 min then water was added. The dough was mixed for 10 min, then it was sheeted to 3mm thickness and formed. Baking was carried out in the laboratory oven at 180C for 10min.

Preparation of date biscuits

The composition of different types of date biscuits fortified with different sources of iron are shown in table (2). The formula of date biscuits were designed to contain 5 mg Fe/100g. Date and powder of iron source mixed to, fill the dough of biscuits pieces and formed in 3 x 5 cm pieces. Baking was carried out in laboratory oven at 180c in 15 min. *(A.A.C.C. 1987)*

Organoleptic evaluation of biscuits

Control biscuit sample and biscuits containing various sources of iron were coded and served to 10 panelists from Food Technology Research Institute, Giza City, Egypt, to rank them according to the degree of acceptability measured by color (20), taste (20) odor (20), texture (20) and appearance (20) according to *Amerine et al. (1965).*

Table 2. Formulation of fortified date biscuits filled with different sources of iron (on fresh weight basis)

Ingredients (g)	Date biscuits with					
	Control	Ferrous sulfate	Thyme	Karkade	Chicory	Purslane
Biscuit dough						
Wheat flour 72%	100	100	91.5	91.4	87.5	90.65
Palm oil	18	18	18	18	18	18
Fresh egg	5	5	5	5	5	5
Sugar	40	40	40	40	40	40
Skim milk powder	2	2	2	2	2	2
Vanilla	0.4	0.4	0.4	0.4	0.4	0.4
Na bicarbonate	1.2	1.2	1.2	1.2	1.2	1.2
Ammonium bicarbonate	0.6	0.6	0.6	0.6	0.6	0.6
Water	16	16	16	16	16	16
The filler:						
Ferrous sulfate	-	0.046	-	-	-	-
Thyme	-	-	8.5			-
Karkade	-	-	-	8.6	-	-
Chicory	-	-	-	-	12.5	-
Purslane	-	-	-	-	-	9.33
Siwi date	100	100	100	100	100	100
Shortening	5	5	5	5	5	5

Organoleptic evaluation of date biscuits

Control samples and date biscuits containing various sources of iron were coded and served to 10 panelists to rank them according to the degree of acceptability measured by crumb color (10), odor (25), taste (25), mastication (20), texture (10) and crust color (10) according to the method described by ***Renzo*** *(1975).*

Chemical analysis:

Samples were analyzed for moisture, crude protein, ether extract and ash according to the methods recommended by *A.O.A.C. (1995).* Total dietary fibers were determined according to *A.A.C.C. (1987).*

Minerals analysis:

Fe, Ca and Zn were determined after wet ashing with concentrated nitric acid and perchloric acid using an atomic absorption spectrophotometer (Perkin- Elmer Instrument Model 23865) according to *A.O.A.C. (1995).*

Statistical analysis

The data obtained from chemical composition and sensory evaluation were statistically analyzed at the 5% level probability procedure according *Senedecor and Cochran (1980).*

RESULTS AND DISCUSSION

Chemical composition of raw materials.

Table (3) summarized the comparative chemical composition of wheat flour (72% extraction), plant sources of iron and siwi dates. The obtained results revealed that plant sources of iron and siwi date had high contents of dietary fibers and ash compared with wheat flour. The results revealed also that available carbohydrates were the predominant component of wheat flour (72% extraction) and siwi date. Also, crude protein content of wheat flour means that this flour is soft and available to be used in making biscuits. These results confirmed those obtained by *Soliman (2000).*

The obtained results revealed also that chicory and purslane had the highest values of protein and ash. These results aqree with those obtained by *El Zaawely (1999).*

Table 3.Chemical composition and minerals of raw materials (%)(on dry weight basis)

Raw materials / Chemical compostion	Wheat flour	Thyme	Karkade	Chicory	Purslane	Siwi date
Crud protein	10.44	10.50	5.16	21.67	20.27	3.97
Ether extract	2.08	3.10	0.45	5.67	3.66	3.25
Available Carbohydrates*	83.95	20.41	11.04	38.81	18.07	73.80
Total dietary fibers	3.10	55.51	71.94	14.5	38.57	14.90
Ash	0.43	10.48	11.41	19.35	19.43	4.08
Moisture	9.63	7.41	11.25	11.6	7.04	20.09
Mineral content (mg/100g)						
Fe	2.10	120.00	133.39	84.28	108.45	1.53
Ca	25.00	1732.61	910.98	853.77	1373.3	977.70
Zn	2.00	1.82	6.57	5.72	5.63	10.5

* Calculated by difference.

Minerals content of raw materials:

Certain minerals content of wheat flour (72%), siwi date and plant sources of iron were determined for Fe, Ca and Zn. The results appear in Table (3). It could be noticed that plant sources have high content of estimated minerals especially Fe and Ca.

Iron content of thyme confirmed with the finding of *Farrell (1990)* and *Soliman (2000).* They reported that iron content of thyme ranges from 122.3 to 124 mg/100g (on dry weight basis). On the other hand, *Hayashi and Seguchi (1998)* found that karkade contains 188mg/100g of iron and *Kassim(2002)* found that karkade contains 151.43 mg/100g.

El Zaawely (1999) reported that iron contents of chicory and purslane ranged from 0.35% to 0.4% on dry weight basis, respectively *Assous (1999)* reported that iron content of siwi date ranges form 0.8 to 7.2 mg/100g.

Organoleptic evaluation of biscuits

The sensory evaluation of biscuit control (100% wheat flour 72%) and biscuits fortified with ferrous sulfate or plant sources of iron was carried out to

evaluate the effect of adding plant powders on the produced biscuits quality. The biscuits were tested for color, texture, taste, flavor and appearance. From the results presented in Table (4), No significant differences ($P > 0.05$) were noticed between control sample and biscuit fortified with ferrous sulfate. Also, there is no significant differences ($P< 0.05$) in odor or texture between samples.

On the other hand, it could be noticed that both color and appearance of biscuits fortified with plant sources had deteriorated and became unacceptable. Therefor, biscuits become unsuitable vehicle to be fortified with this plant sources and another substitutes must be used.

The decreasing in color and appearance scores were mainly due to the Egyptian panelists who usually prefer the white than the darker grades ***(Emam et** al., 1989).*

Table 4. Organoleptic evaluation of biscuits and date biscuits fortified with plant sources of iron

Biscuit	Color 20	Taste 20	Odor 20	Texture 20	Appearance 20	-
Control	18.9 A	18.8 A	18.4 A	18.7 A	18.7 A	-
Ferrous sulfate	18.7 A	18.7 A	18.1 A	18.3 A	18.4 A	-
Thyme	13.0 B	17.1 AB	16.9 A	17.3 A	14.6 B	-
Karkade	13.0 B	16.4 AB	16.8 A	17.9 A	12.8 B	-
Chicory	12.5 B	14.8 B	16.8 A	16.8 A	13.6 B	-
purslane	14.5 B	16.4 AB	17.1 A	16.9 A	14.8 B	-
L.S.D.	6.632	4.123	NS	NS	6.721	
Date biscuits	Crumb color (10)	Odor (20)	Taste (25)	Texture (10)	Crust color (10)	Mastication (20)
Control	9.5 A	24.6 A	24.2 A	9.5 A	9.4 A	19.1 A
Ferrous sulfate	9.5 A	24.6 A	24.2 A	9.5 A	9.4 A	19.1 A
Thyme	9.5 A	23.4 A	20.8 B	9.5 A	9.4 A	19.1 A
Karkade	9.5 A	24.3 A	23.6A	9.5 A	9.4 A	19.1 A
Chicory	9.5 A	23.5 A	22.6 A	9.5 A	9.4 A	19.1 A
Purslane	9.5 A	21.8 B	20.5 B	9.5 A	9.4 A	19.1 A
L.S.D.	NS	2.951	4.522	NS	NS	NS

Significant at 0.05 probability level(means with the same letters are not significantly different)

Organoleptic evaluation of date biscuits

Results in Table (4) showed that biscuits with plant sources of iron were close to control and biscuits fortified with the chemical source of iron (ferrous sulfate) in crumb color, mastication, texture and crust color. Also, there was no significant differences ($P<0.05$) between the control, biscuits fortified with ferrous sulfate and

biscuits fortified with karkade or chicory in all characteristics. Taste scores of biscuits fortified with thyme or purslane powders were decreased.

Chemical composition of date biscuits

Table (5) shows the chemical composition, energy and minerals content of date biscuits fortified with different sources of iron. The results revealed that the moisture content, ether extract and protein content of different types of date biscuits were almost the same. Also, carbohydrates content of date biscuits were similar. Total dietary fibers ranged from 6.31% to 7.3% on dry weight basis.

Energy content of date biscuits fortified with plant sources of iron were slightly decreased due to the lower content of these plant sources from carbohydrates and ether extract. Ash content of the same sample increased than control and ferrous sulfate biscuits. These increments reveal to the high content of plant sources of iron as a part of ash content.

Table 5. chemical composition, energy content and mineral content of date biscuits fortified with different sources of iron(on dry weight basis).

Composition (%)	Date biscuits prepared with					
	Control	Ferrous sulfate	Thyme	Karkade	Chicory	Purslane
Crude protein	6.5	6.5	6.51	6.4	7.5	7.3
Ether extract	13.72	13.72	13.71	13.00	13.8	13.70
Carbohydrates *						
Total dietary	71.59	71.59	70.67	70.87	69.83	69.41
Fibers	6.79	6.79	7.3	7.9	6.31	7.1
Ash	1.4	1.4	1.81	1.83	2.56	2.49
Energy (kcal)	435.84	435.84	432.11	426.08	433.52	430.14
Moisture	14.38	14.38	14.38	14.38	14.38	14.38
Mineral content (mg/100g)						
Fe	1.69	5.88	5.8	5.2	5.03	5.12
Ca	448.39	448.39	520.27	475.91	489.23	503.00
Zn	6.65	6.65	5.62	5.79	5.66	5.78

* Carbohydrates calculated by difference

Minerals content of date biscuits:

Table (5) shows the content of minerals of date biscuits fortified with plant sources of iron. It could be noticed that iron content of fortified date biscuits increased from 1.6 mg/100g in control sample to 5 mg/100g due to the fortification with plant sources of iron. This amount (5 mg/ 100g) equals the iron content of biscuits used in the school meal programs According to RDA, consumption of 100g of these biscuits could be able to meet half of daily RDA of iron. *(RDA,1989).*

Iron content of karkade agreed with the findings of *Barakat(2003).* He reported that iron content of karkade was 113.39. While iron in date biscuits was 5.2 mg/100g when he used 5 mg/100g of iron in the mixture.

From Table (5) it could also be noticed that the calcium content of fortified date biscuits increased with fortification due to the high content of plant sources from this element. The results show, also that high content of zinc at control and fortified biscuits are due to the high content of siwi date from this element.

It could also be noticed that consumption of 100g of these products could meet half of the daily requirements of both zinc and calcium according to RDA estimated by *National Research Council (1989).*

Table 6. Ingredients cost of fortified date biscuits

Ingredients	Price of Kg (P.T.	Control	Biscuits filled with				
			Ferrous sulfate	Thyme	Karkade	Chicory	Purslane
Wheat flour 72%	110	11	11	10.06	10.05	9.62	9.97
Ferrous Sulfate	4000		0.2				
Thyme	1600			10.2			
Karkade	1600				10.32		
Chicory	100						
Purslane	200					1.25	2.0
Date	125	12.5	12.5	12.5	12.5	12.5	12.5
Palm oil	500	9.0	9.0	9.5	9.0	9.0	9.0
Fresh egg	500	2.5	2.5	2.5	2.5	2.5	2.5
Sugar	200	8.0	8.0	8.0	8.0	8.0	8.0
Skim milk powder	1000	2.0	2.0	2.0	2.0	2.0	2.0
Vanilla							
Na bicarbonate	5000	2.0	2.0	2.0	2.0	2.0	2.0
Ammonium	1200	1.44	1.44	1.44	1.44	1.44	1.44
Bicarbonate	500	0.3	0.3	0.3	0.3	0.3	0.3
Total weight	-	265	265	265	265	265	265
Total cost (P.T.)	-	46.74	48.94	58.00	58.11	48.61	49.71
Cost of 100g (P.T.)	-	18.00	18.82	22.30	22.35	18.69	18.75
Increment of cost (%)	-	-	4.57	23.43	24.16	3.8	4.21

Ingredients cost of the fortified date biscuits

Price of the ingredients, cost of 100g of fortified date biscuits and increment percent of the cost were calculated and date are shown in Table (6). The results show that cost of 100g of date biscuits ranged from 18 P.T. for control to 22.35 P.T. for date biscuits with karkade. Date biscuits with chicory recorded the lowest cost among fortified date biscuits.

Also, it is clear that increment percent of the cost based on control biscuits ranged from 3.8% for date biscuits with chicory and 24.16% for date biscuits with karkade.

Romia (1998) reported that, although iron fortified bread were more expensive among wheat bread, its nutritional benefit is considered more valuable in providing the majority of population with iron to overcome the global prevalence of nutritional iron deficiency anemia in Egypt.

It could be concluded that thyme, karkade, chicory and purslane can be used as safe sources of iron in producing cereal products rich in iron as functional foods to overcome iron deficiency problem.

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تدعيم بعض انواع من البسكويت ببعض الأضافات النباتيه الغنية بالحديد

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تهدف هذه الدراسة إلى إنتاج بسكويت مدعم بمصادر نباتية غنيـة بالحديـد كأحـد الأغذيـة الوظيفية المدعمة لعلاج انيميا نقص الحديد. تم طحن اوراق الزعتـر والشـيكوريا وازهـار الكركدية ونبات الرجلة بعد تجفيفها. تم تقدير نسبة الحديد فى كل نبات ثم خلط كل مسـحوق على حدة كمصدر للحديد.

استخدم المخلوط فى انتاج بسكويت جاف وبسكويت بلح لتصل نسبة الحديـد إلـى ٥ مجـم/ ١٠٠جم (على اساس الوزن الجاف) وكذلك كبرتيات الحديدوز المستخدمة كمصـدر مقارنـة كيماوى للحديد. تم دراسة التركيب الكيماوى والاختبار الحسى والتكلفة الاقتصادية للبسكويت الناتج.

لا توجد فروق معنوية فى بسكويت البلح المدعم بالمصادر النباتية الغنية بالحديد مـع الـبلح السيوى فى اللون والطعم والقوام وخواص المضغ مقارنة بالعينة المقارنة الضابطة.

وجود فرق معنوى فى الطعم فى العينات المحتوية على الزعتر والرجلة والعينـة المقارنـة الضابطة. بالنسبة للبسكويت الجاف المدعم بالزعتر والكركدية والشـيكوريا والرجلـة كـان مقبول من حيث الرائحة والطعم والقوام مقارنة بالعينة المقارنة الضابطة.

بحساب تكلفة مكونات بسكويت البلح تراوحت نسبة الزيادة فى التكلفة من ٣,٨% فـى حالـة بسكويت البلح المدعم بالشيكوريا إلى ٢٤,١٦% فى حالة بسكويت البلح المدعم بالكركديه.