QUALITY AND NUTRITIVE VALUE OF BISCUITS AS AFFECTED BY ADDING DEHYDRATED SPLEEN AND SOME FLAVORS

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(Manuscript received 1st March 2007)

Abstract

Anemia is a worldwide public health problem. Prevalence estimates indicate anemia is present in 43% of children less than 4 years of age. It is caused by nutritional deficiencies (i.e., iron, folic acid, vitamin B12, and vitamin A), infection, and blood disorders. Among the different types of anemia, iron-deficiency anemia is the most common. The World Health Organization (WHO) estimates that 50% of anemia can be attributed to iron deficiency.

Using beef by-products such as spleen in a formulated food for the nutrition of low income families in developing countries can be helpful in reducing anemic health problems because spleen is a very rich source of iron.

So, the present study was aimed to develop biscuits fortified with pre-boiled spleen powder as acceptable, highly nutritional value and economic food for solving the iron-deficiency anemia problem compared with unfortified biscuits and commercial biscuits.

The results revealed that for the fortified biscuits with pre-boiled spleen powder, the protein content was 14.6g/100g biscuits equal 2 times of protein amount in unfortified biscuits and commercial biscuits. Also, their content of iron equal 6 folds of that in unfortified biscuits. Banana and cinnamon biscuits were the most preferable by panelists, followed by vanillia and cocoa biscuits compared with unfortified biscuits. Also, the cinnamon was of anti-microbial and specially, anti bacterial effect followed by cocoa. According to organoleptic and microbiological evaluation, the cinnamon biscuit was selected for biological evaluation. After 2 weeks of repletion period, both Hb and serum iron of iron-depleted rats progressived gradually until reached to 10.1g and 63 µg, 10.9g and 123µg and 11.6g and 134µg for rats group fed on fortified biscuits, fortified plus vitamin C and group used Fefol in iron drug (Ferrous sulfate), respectively. In this case rates surpassed indicated by mild anemia stage for Hb = 10–10.9g / 100ml, except of group fed unfortified biscuits which was 8.2g / 100ml Hb and 52µg serum iron. Percentage of iron absorbance was highest percent (97.7%) for group fed on fortified biscuits plus vitamin C followed by 95.1, 94.6 and 90.7% for iron medical group, fortified biscuits group and control group, respectively. At last, rats group fed on unfortified diet was 75.5%. Also, the results recorded the highest HRE, IU and RBV for rats group fed on fortified biscuits plus vitamin C (18.40%, 9.70 mg and 33.95%, respectively) followed by rats group fed on fortified biscuits without adding vitamin C (13.54%, 6.84mg and 23.94%, respectively). At last, the rats group fed on unfortified biscuits recorded the lowest values (4.28%, 0.25mg and 0.89%, respectively).

The results obtained on 100g fortified biscuits with spleen after words, boiled and dried as iron and protein source increased 55.7 and 39.6 % about an unfortified biscuits and commercial biscuits, respectively.

INTRODUCTION

The common nutritionally induced deficiency condition in the world is anemia. The incidence of this condition would decrease if women would increase their intake of vitamin C, which improves the modest absorption of iron from foodstuffs. Iron improves general health and resistance, and protects against infections and many other diseases. Although many people, however consume more than 6 mg/1000 kcal or 18mg/day, which is the Recommended Dietary Allowance (RDA). This does cover the absolute minimum requirement for an adult. The best dietary sources of iron are meat, offal, egg and seafood (Tolonen, 1990).

In Egypt, iron deficiency is responsible for more than 75 % of the anemia cases. It is particularly common among preschool and school age children, and women specially pregnant and lactating, in both rural and urban areas. The national nutrition survey conducted in 1978 (Nutrition Institute CDC-AID, 1978) revealed that percentage of preschool children with Hb values below 11 g/dL was 38% while the prevalence of moderate anemia Hb < 9.5 g/dL was about 12% (Hussein et al. 1985).

Subba (2002) studied a simple type of snack which was developed from a mixture of wheat flour, cassava flour and pulverized meat offal. Wheat flour, cassava flour and dehydrated bovine lung, liver and spleen were mixed with water to form dough. The dough was steamed, cut into thin slices and dried. The snack, which is fried before consumption, contains 4.3% protein, 150 mg lysine/100g protein, 5 mg iron, 51.5 mg calcium and 20 µg vitamin A / 100g sample.

Recent statistics from the World Health Organization indicate that 66-80% of the world´s population is iron deficiency and that 30% is anemic, as a consequence of iron deficiency. Although iron deficiency is most prevalent in developing countries, it is also, a problem for infants, adolescent girls, women of child-bearing age and older people in developed countries, including the UK. WHO defined anemia amongst children aged 6 months to 6 years a hemoglobin value of < 110g/L. However, recent studies using outcome measures to assess the effects of deficiency have suggested that a cut off of < 95 g/L for infants and < 100-105g/L for children aged 1-12 years, (Stanner, 2003).

Siegel et al. (2006) found that anemia and iron deficiency increased strongly with age and poor status among the studied children, anemia was prevalent, 58% of the children had a hemoglobin < 105 g/L. Iron-deficiency anemia was present in 43% of the children. Sever anemia however, was rare: less than 2% of the children had a hemoglobin < 70g/L.

Krebs et al., (2006) observed the importance of complementary foods to meet iron requirements of the older infant which has long been recognized anemic, and iron-fortified cereal is commonly recommended as a first complementary food to prevent development of iron deficiency. Increased use of animal products because the meat is an excellent source of both iron and zinc.

The aim of the present study is to develop biscuits fortified with dehydrated spleen as a natural iron source to cover all the daily Recommended Dietary Allowance (10mg Fe), for children in pre-school and school age and half the daily RDA for adults of iron compared with unfortified biscuits and commercial biscuits (Mary type).

MATERIALS AND METHODS

Materials:

1-Wheat flour 72% extraction was obtained from Flour Land Company at 6th October City, Zone 3, Giza, Egypt.

2-Baking ingredients as skimmed milk powder, butter, sunflower oil, sugar, egg, baking powder, vanillia, cocoa, banana flavor and cinnamon were purchased from the local market.

3-Spleen obtained from a private butchery.

Methods:

Preparation of spleen:

Spleen was washed, boiled for 30min, cut into slices and dried under vacuum at 80°C for 6hr followed by blending and packaging in polyethylene inter plastic cans in a refrigerator until use .

Preparation of biscuits:

Biscuits were prepared according to the standard procedure for semi hard sweet biscuits given by A.A.C.C. (1994). Fat, sugar, whole egg and vanillia were mixed in a dough mixer using the flat beater for 1 min. then scraped down and continued to mix for 3 min at high speed, wheat flour, skimmed milk, baking powder added. Spleen powder added to the mixture at low speed, then dough was sheeted to 3 mm thickness, circles, cut of paste pieces was done by use of templates with an outer diameter of 60 mm, and then, it was baked at 170 to 180 °C for 12min. The formula of biscuits is shown in Table (1).

Table 1. The formula of biscuits.

Ingredients	Amounts (g)	
	Unfortified biscuits (control)	Fortified biscuits with 10% pre-boiled spleen powder
Wheat flour	100	100
Sugar	30	30
Butter	10	10
Sunflower oil	5	5
Skimmed milk powder	5	5
Egg (whole, fresh)	20	20
Baking powder	4	4
Vanillia	1	1
Pre-boiled spleen powder	-	20
Flavors*	5	5

Flavors: vanillia or banana or cinnamon or cocoa.

Chemical analysis:

Moisture, protein, ash, fat, fiber and total carbohydrates were determined according to the A.O.A.C. (2000).

Iron analysis:

Fe was determined after wet ashing with concentrated nitric acid and perchloric acid using an atomic absorption spectrometer (Perkin-Elmer 3300 Model-Germany) according to the method of Gordon, (1978).

Sensory evaluation of biscuits:

Biscuits were organoleptically evaluated for their taste, color, texture, odor and overall palatability according to the method of Faridi and Rubenthaler (1984) by ten panelists using numerical scale of one to ten (where one = very bad and 10 = excellent.)

Microbiological evaluation:

Total bacterial count:

The medium for total bacterial count (Nutrient agar) was prepared as described by Smith and Townsend, (1999).

Yeasts and molds count:

The medium for yeasts and molds count (Sobouraud Dextrose agar) was prepared as described by Smith and Townsend, (1999).

Biological evaluation:

A total of 25 male Wistar rats were used immediately after weaning (21-23 days) and studied for a period of 35 days. On the first day of the study the animals were

weighed and submitted to capillary blood collection for the determination of hemoglobin (Hb) by complete blood count (CBC) and serum iron by the method of Carter (1971). The animals were then placed in individual stainless steel cages with feeders and glass drinking water containers.

The rats were divided into two groups, the first group was the control (basal diet) contains 5 rats. The amount of iron added to the diet for the control group was 179mg ferrous sulfate per kg diet which contains 36mg of iron. Basal casein diet was prepared according to the norms of the Association of Official Chemists. The second was the experimental group (free iron diet) using depletion-repletion methods. Rats were iron depleted for 14 days, during this period, the animals were weighed and anesthetized with ether and capillary blood was collected on the 4^{th}, 7^{th}, 11^{th} and 14^{th} days for the determination of hemoglobin (Hb) and serum iron.

During the repletion period (21days), rats of the second group were divided into 4 groups, the rats were fed diets based on unfortified biscuits, fortified biscuits with spleen, fortified biscuits with spleen and vitamin C and the last group supplemented with ferrous sulfate as drug (Fefol capsule), respectively. Five rats in each group were weighed and food intake of the rats was recorded daily considering food spills. Feces were collected and separated from split food, the feces were dried, weighed, ground and analyzed for Fe according to the same methodology used for the diets. Also, the blood samples were collected weekly for hematological analysis.

Feed Conversion efficiency (FCE) = g weight gain / g food intake

Iron balance = mg Fe intake – mg Fe in feces.

% Fe absorption = {Iron balance x 100} /mg Fe intake

mg Fe Hb = { body weight (g) x Hb (g/L) x 6.7 x 0.335} / 10000

% HRE = [mg Fe Hb (final) - mg Fe Hb(initial)] ^{2}

Iron utilization (mg) = (% HRE X % iron in the intake diet) / 100

Relative Biological Value (RBV) = (Iron utilization from the test sample x 100) / Iron utilization from diet fortified with Fe SO_4.

(Hernandez et al., 2003)

Costs of fortified biscuits were calculated according to Harper et al., (1983).

Statistical analysis: The obtained results of organoleyptic evaluation and biological evaluation were subjected to analysis of variance according to the methods proposed by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Chemical composition of raw ingredients:

Table (2) shows the comparative chemical composition of ingredients which formulated the biscuits. The pre-boiled spleen powder had the highest protein and iron content reached 64.9g and 97.5mg/l00g spleen on dry weight, respectively, followed by skimmed milk powder containing 38g protein and whole egg contained 13.8g /100g on wet weight. Also, spleen contained the highest percent of ash that reached 6.5g/100g on dry weight. Whereas, wheat flour contained the highest percent of carbohydrates 76g / 100g. These results agree with those of El-Moudy (1979) who found that the chemical composition of raw beef spleen that were shown 77.24, 21.5, 2.6 and 1.5% for moisture, protein, fat and ash, respectively.

Chemical composition of formulated biscuits:

The chemical contents of fortified biscuits with pre-boiled spleen powder compared with unfortified biscuits and commercial biscuits are shown in Table (3). The results revealed that the protein content of the fortified biscuits with spleen was 14.6g/100g biscuits equal 2 fold of protein in the unfortified biscuits and commercial biscuits. Also, fortified biscuits content of iron equals 6 folds of iron content in unfortified biscuits. So, 100g of the fortified biscuits can cover the daily requirements of children from protein and iron.

Organoleyptic evaluation:

One of the limiting factors for consumer acceptability is the organoleyptic properties. Therefore, color, taste, odor, texture, appearance and overall acceptability of biscuits were determined and the data are shown in Table (4). The statistical analysis of organoleyptic evaluation revealed no significant differences between the fortified biscuits treatments in texture and appearance. Whereas, odor and taste showed significant differences in flavor of cinnamon and banana biscuits followed by vanilla and then cocoa samples compared with unfortified biscuits. On the contrary, the unfortified samples, vanilla and banana treatments recorded the best color score followed by cinnamon and cocoa biscuits. According to overall acceptability, cinnamon, banana and vanilla biscuits were the most preferable by panelists, followed by cocoa samples. It may be concluded that the significant differences between samples may be due to flavors added and not to spleen where, there are not significantly differences between unfortified biscuits and samples no. (1,2 &4) which were fortified with spleen.

Microbiological evaluation:

The microbiological test of fortified biscuits with different flavors compared with unfortified biscuits during storage period at room temperature for 9 months are shown

in Table (5). Total bacterial count (TBC) and yeast / mold of samples showed some differences among treatments. Data revealed that TBC and Y/M were not found at zero time in the unfortified, cocoa and cinnamon biscuits whereas, the previous microbes grew in fortified biscuits plus added vanilla and banana. After 3 months, cocoa and cinnamon biscuits were still without microbial growth while the reverse recorded in other samples including that of unfortified sample. After 6 months, total bacterial count was nil in cinnamon biscuits whereas Y/M grew. The microbial count slightly increased in all samples until reached maximum after 9 months. From the previous data of table (5) may be concluded that cinnamon was anti-microbial and specially, anti bacterial followed by cocoa biscuits.

Biological evaluation of formulated biscuits:

As for the organoleptic test and microbiological analysis, cinnamon biscuits were selected for biological evaluation, compared with rats fed on unfortified biscuits, fed on fortified biscuits with vitamin C and the group used iron medicine as capsule (Fefol), and the data are given in Table (6). The results showed the effect of iron deficiency on rats fed on free-iron diet compared with the control group which was fed on basal casein diet contained 36mg iron as $FeSo_4$ in the depletion period (14 days). Rats body weight was 75g compared with the control was 93g after 14 days, and Hb reached to < 7 g / 100ml (severe anemia stage), after 11 and 14 days: 6.8 and 5.7g/100ml, respectively compared with the control group which showed 12.4 and 13.7g/100ml, respectively. The previous results agree with Vieira et al., (2000) who observed a reduction in weight occurred in the anemic animals starting on the 5^{th} day in their study compared to control (C), with a progressive increase up to the 14 days (hemoglobin: C = 13.27 and E = 5.37g / 100ml.

The effect of repletion stage of anemic rats is given in Table (7). The results obtained show that iron-depleted rats which were fed on fortified biscuits were of increased Hb and serum iron to 7.9g and 72 µg/100ml, respectively after week from iron repletion (moderate anemia = 7 – 9.9g / ml). While adding vitamin C to diet, both Hb and serum iron increased to 8.5g and 97µg / 100ml mean while rats groups which were fed on basal casein diet (control) or given medical iron (drug) showed higher Hb, being 14.5 and 8.8g /100ml, and 130 and 90 µg/100ml for serum iron, respectively. After 2 weeks, both Hb and serum iron progressive gradually until reached 10.1g and 103 µg, 10.9g and 143µg and 11.6g and 134µg for rats group fed on fortified biscuits, fortified plus vitamin C and that used medical iron, respectively. (mild anemia stage for Hb = 10 – 10.9g / 100ml). Unfortified biscuits showed lower levels being 8.2g and 52µg / 100ml for Hb and serum iron, respectively. The previous results agree well with Hernandez et al., (2003).

The data given in Table (8) show iron balance and percentage of iron absorbance of rats groups. The results proved that the percentage of iron absorbance had the highest percent of 97.7% for group fed on fortified biscuits and vitamin C followed by 95.7, 94.7 and 90.7 % for medical iron group, fortified biscuits group and control group. The last value was that of rats group fed on unfortified diet was 68.0 %.

Hemoglobin regeneration efficiency (HRE), iron utilization (IU) and relative biological value (RBV) are shown in Table (9). The results recorded the highest HRE, IU and RBV values for rats group fed on medical iron group (drug) revealed highest values being 21.07%, 28.57 mg and 100 %, respectively. Followed by rats groups fed fortified biscuits plus vitamin C (F+V) and only with fortified biscuits (F) groups (18.4%, 9.70 and 33.95) and (13.54%, 6.84 mg and 23.94%), respectively and at last came the rats group fed with unfortified biscuits recorded the lowest values which were 4.28%, 0.25mg and 0.89%, respectively, control sample showed 13.62%, 2.21mg and 7.74%, respectively.

Cost of fortified biscuits compared with unfortified and commercial biscuits:

According to the organoleyptic and microbiological evaluation, the cinnamon biscuits were selected to calculate the cost of their ingredients per 100g. Cost of fortified biscuits compared with unfortified biscuits is shown in Table (10). The results revealed that cost of 100g fortified biscuits with spleen as iron and protein source increased by 55.7 and 39.5% compared with unfortified biscuits and commercial biscuits. Such increase is justified due to the benefit of spleen biscuits for anemic children.

Table 2. Chemical composition and iron content of raw ingredients (%).

Chemical** composition	Wheat flour	Skimmed milk powder	Butter +Oil	Sugar	Whole egg wet wt.	Spleen		
						Fresh	Boiled	Dried
Moisture	10.2	-	-	-	72.5	75.6	69.79	9.60
Protein	10.6	38	-	-	13.8	18.9	21.65	64.9
Ash	0.58	-	-	-	0.93	1.38	2.15	6.45
Fat	1.42	-	78	-	12.3	2.40	1.80	5.40
Fiber	0.50	-	-	-	-	-	-	-
Carbohydrates*Iron (mg)	76.7	-	-	99.7	0.47	1.72	4.61	13.7
Other components**	2.10	-	-	-	2.50	25.8	32.5	97.5

*Carbohydrates were calculated by difference.
**Chemical composition of other components (flavors) was not considered.

Table 3. Chemical composition, iron and total calories content of fortified biscuits compared with unfortified biscuits and commercial biscuits (%).

Chemical composition	Control	Fortified biscuits*	Commercial biscuits**
Moisture	10.2	9.8	10
Protein	7.91	14.6	7
Ash	0.45	1.05	?
Fat	10.8	10.3	10
Fiber	0.30	0.25	?
Carbohydrates	70.4	64.0	67
Iron (mg)	1.80	11.1	6
Kcal /100g	410.2	420.3	386.0

* Fortified biscuits with pre-boiled spleen powder.
**Commercial biscuits = Mary

Table 4. Organoleyptic evaluation of fortified biscuits compared with unfortified biscuits.

Biscuits No.	Sensory evaluation						
	Color (10)	Texture (10)	Odor (10)	Taste (10)	Appearance (10)	Overall Acceptability (10)	Grade
Unfortified biscuits	9.5^{A}	9.5^{A}	$9.2B^{C}$	$9.0B^{C}$	9.5^{A}	9.3^{A}	Excellent
(1)	9.5^{A}	$9.3A^{B}$	9.0^{C}	$9.0B^{C}$	$9.2A^{B}$	$9.2A^{B}$	Excellent
(2)	9.1^{B}	$9.4A^{B}$	9.8^{A}	$9.3A^{B}$	9.4^{A}	9.4^{A}	Excellent
(3)	8.0^{D}	9.1^{B}	9.3^{B}	8.8^{C}	9.0^{B}	8.9^{B}	Very good
(4)	8.5^{C}	$9.4A^{B}$	9.5^{B}	9.5^{A}	$9.2A^{B}$	$9.2A^{B}$	Excellent
L.S.D (0.05)	0.243^{A}	0.2891	0.2762	0.3068	0.2863	0.2960	-

Mean values in the same colum with the same letter are not significantly different (at 0.05 level).
(1): Fortified biscuits with pre-boiled spleen powder and 5% vanillia.
(2): Fortified biscuits with pre-boiled spleen powder and 5% banana flavor.
(3): Fortified biscuits with pre-boiled spleen powder and 5% cacoa.
(4): Fortified biscuits with pre-boiled spleen powder and 5% cinnamon.

Table 5. Microbiological evaluation of fortified biscuits with pre-boiled spleen powder and different flavor compared with unfortified biscuits during storage period at room temperature.

Biscuits Types	Storage period (months)							
	Zero time		After 3		After 6		After 9	
	TBC	Y / M	TBC	Y / M	TBC	Y / M	TBC	Y / M
Unfortified biscuits	N.D	N.D	0.1×10^2	0.5×10^2	3×10^2	9×10^2	6×10^2	12×10^2
(1)	0.8×10^2	0.1×10^2	2.5×10^2	0.8×10^2	4×10^2	1.5×10^2	12×10^2	6×10^2
(2)	0.5×10^2	3×10^2	7×10^2	5×10^2	9×10^2	15×10^2	24×10^2	28×10^2
(3)	N.D	N.D	N.D	N.D	0.2×10^2	0.3×10^2	1.5×10^2	2×10^2
(4)	N.D	N.D	N.D	N.D	N.D	0.5×10^2	0.3×10^2	2×10^2

TBC: Total bacterial count.
Y / M: Yeast and mold count.
(1): Fortified biscuits with pre-boiled spleen powder and 5% vanillia.
(2): Fortified biscuits with pre-boiled spleen powder and 5% banana flavor.
(3): Fortified biscuits with pre-boiled spleen powder and 5% cacoa.
(4): Fortified biscuits with pre-boiled spleen powder and 5% cinnamon.
N.D: Not detected.

Table 6. Rats body weight, total food intake and haematological parameters (Hb and serum iron) of rats fed on basal diet (control) and free-iron diet during the depletion period (14 days).

Period (days)	Diet groups	Rats body weight (g)	Food intake weight (g)	Hb g/100ml	Serum iron µg/100 ml
0	C	52	-	10.3	-
	F	56	-	10.5	-
4	C	60	40	10.7	77
	F	59	35	9.70	60
7	C	72	77	11.1	80
	F	63	50	8.20	50
11	C	84	125	12.4	85
	F	69	72	6.80	39
14	C	93	170	13.7	90
	F	75	78	5.70*	31

C: Control diet.
F: Free-iron diet.
* Sever anemia < 7mg.

Table 7. Feed Conversion Efficiency (FCE) and haematological parameters (Hb and serum iron) of rats fed diets based on basal diet (control), unfortified biscuits diet, fortified biscuits diet*, fortified biscuits diet + vitamin C and Fe medication as drug during the repletion period (3 weeks).

Period (week)	Diet groups	Body weight (g)	Food intake (g)	Weigh gain(g)	FCE (g)	Hb g/100ml	Serum iron µg/100 ml
1	C	124	195	31	0.159	14.5	130
	U	106	188	26	0.138	6.9*	39
	F	109	212	39	0.184	7.9**	72
	F+V	112	218	42	0.193	8.5**	97
	D	110	146	30	0.205	8.8**	90
2	C	149	320	56	0.175	15.1	154
	U	132	290	52	0.179	8.2**	52
	F	138	330	68	0.206	10.1	103
	F+V	142	342	72	0.211	10.9	143
	D	155	337	75	0.222	11.6	134
3	C	187	450	94	0.208	15.6	185
	U	138	330	68	0.206	9.3**	69
	F	166	455	96	0.211	12.4	131
	F+V	175	475	105	0.221	13.1	187
	D	182	452	102	0.226	13.8	194

C: Control basal diet.
U: Unfortified biscuits with spleen.
F: Fortified biscuits with pre-boiled spleen.
F+V: Fortified biscuits with pre-boiled spleen + Vitamin C (Ascorbic acid).
D: Drug (Fefol capsule contains 150mg Fe So_4 + 0.5mg folic acid).
* Sever anemia = < 7mg.
** Moderate anemia = 7 – 9.9mg
Mild anemia = < 11mg (10 -10.9mg).

Table 8. Iron balance and absorption of anemic rats fed on diets based on basal diet (control) unfortified biscuits, fortified biscuits, fortified biscuits +Vitamin C and Fe medication as drug after the repletion period (3 weeks).

Diets	Fe in diet mg / 100g	Food intake (g)	Fe intake mg	Fe in feces mg	Iron Balance	% Fe Absorbance
C	3.6	450	16.2	1.5	14.7	90.7
U	1.8	330	5.94	1.9	4.04	68.0
F	11.1	455	50.5	2.7	47.8	94.7
F +V	11.1	475	52.7	1.2	51.5	97.7
D	30.0	452	135.6	5.9	129.7	95.7

C: Control basal diet.
U: Unfortified biscuits with spleen.
F: Fortified biscuits with pre-boiled spleen.
F+V: Fortified biscuits with pre-boiled spleen + Vitamin C (Ascorbic acid).
D: Drug (Fefol capsule contains 150mg Fe So_4 + 0.5mg folic acid).

Table 9. Hemoblobin regeneration efficiency (HRE), Iron utilization and relative biological value (RBV) in anemic rats fed on diets based on basal diet (control), unfortified biscuits,fortified biscuits, fortified biscuits + VitaminC and Fe medication as drug after the repletion period 3 weeks.

Diets	Body weight gain (g)		Hb g/100ml		Fe in Hb mg		HRE %	Iron Utilization mg	RBV %
	Initial	Final	Initial	Final	Initial	Final			
C	93	187	13.7	15.6	2.86	6.55	13.62	2.21	7.74
U	80	148	5.7	9.3	1.02	3.09	4.28	0.25	0.89
F	71	166	5.9	12.4	0.94	4.62	13.54	6.84	23.94
F+V	70	175	5.5	13.1	0.86	5.15	18.40	9.70	33.95
D	79	182	5.9	13.8	1.05	5.64	21.07	28.57	100

C: Control basal diet.
U: Unfortified biscuits with spleen.
F: Fortified biscuits with pre-boiled spleen.
F+V: Fortified biscuits with pre-boiled spleen + Vitamin C (Ascorbic acid).
D: Drug (Fefol capsule contains 150mg Fe So4 + 0.5mg folic acid).

Table 10. Ingredients cost of fortified biscuits compared with unfortified biscuits and commercial biscuits.

Ingredients	Amount (g)	Price (P.T.)		
		Unfortified biscuits	Fortified biscuits	Mary
Wheat flour	100	25	25	(Flour- Sucrose- Veg. Shortening- Glucose-High Fructose –Milk powder- Raising agents (NH4 HCO4+NaHCO4 Vanillin- Food flavors). -
Butter	10	18	18	
Sunflower oil	5	3	3	
Skimmed milk powder	5	9	9	
Egg (whole)	20	20	20	
Sugar	30	10	10	
Packing powder	4	5	5	
Vanillia	1	15	15	
Other flavours	5	5	5	
Spleen	20	-	80	
Total	200	180g /110 p.s.	200g / 190 p.s.	170g /150 p.s.
Cost of 100g (p.s.)	100	61	95	-
Adding 30% processing and packaging	100	79.3	123.5	88.5
% Of increment	100	55.74	-	39.55

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تأثيرإستخدام الطحال المجفف و بعض النكهات على جودة البسكويت المدعم و قيمته الغذائية

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الإنيميا من أهم المشاكل الصحية التى تمثل ٤٣ % من اللأطفال الأقل من ٤ سنوات و من أهم أنواع الأنيميا هى الأنيميا الغذائية التى يرجع سببها إلى نقص عنصر الحديد فى الجسم و الذى يحتاجه الإنسان بكميات قليلة تصل إلى ١٠ملجم للأطفال و ١٨ ملجم للبالغ و حيث أن بعض المنتجات الثانوية للحم البقرى تعتبر مصدرا غنيا بالحديد مثل الطحال فقد كان الهدف من الدراسة هو تدعيم البسكويت بمصدر طبيعى غنى بالحديد و قليل التكلفة مثل الطحال.

أوضحت نتائج الدراسة أن محتوى الطحال من الحديد بعد السلق يصل إلى ٣٢،٥ ملجم/١٠٠جم على أساس الوزن الرطب و بعد التجفيف وصل إلى ٩٧،٥ملجم/١٠٠حم على أساس الوزن الجاف. وجد أن تدعيم البسكويت بنسبة ١٠% طحال مجفف مع أستخدام نكهات مختلفة مثل (فانيليا – نكهة الموز – كاكاو – قرفة) إحتوى على نسبة بروتين تصل إلى ١٤،٦% وهى ضعف النسبة التى يحتويها البسكويت الغير مدعم والبسكويت التجارى. ووصلت نسبة الحديد فى البسكويت المدعم إلى ١١،١ملجم/١٠٠جم أى بما يعادل ٦ أضعاف نسبة الحديد فى البسكويت الغير مدعم و بإجراء التقييم الحسى عليها، سجل بسكويت الموزو القرفة أعلى درجة يليها الفانيليا و أخيرا الكاكاو وأثبت التقييم الميكروبيولوجى (العد الكلى للبكتريا – الخميرة / الفطر) أن القرفة مضادة للميكروبات و خصوصا البكتريا لم تظهرفى عينات بسكويت القرفة إلا بعد ٦ شهورو ذلك عند تخزين البسكويت المدعم بنكهاته المختلفة مقارنة بالبسكويت الغيرمدعم الذى ظهرت فيه البكتريا بعد ٣ شهور.

بناء على التقييم الحسى و الميكروبى ، تم إختيار بسكويت القرفة فى إجراء التقييم البيولوجى عليها و ذلك بتغذية مجاميع الفئران المصابة بالأنيميا (تم تغذيتها على أكل خالى من الحديد حتى وصلت إلى أنيميا حادة و فيها نسبة الهيموجلوبين أقل من ٧ جم/١٠٠مل دم / أسبوعين) ثم التغذية على بسكويت مدعم بالطحال، بسكويت مدعم بالطحال ومضاف للوجبة·فيتامين C وبسكويت غير مدعم مقارنة بالكنترول (كازين). زاد الهيموجلوبين و تركيز الحديد فى السيرم تدريجيا وإجتاز مرحلة الأنيميا الخفيفة (أقل من ١١جم/١٠٠مل دم) وأصبح طبيعى و ذلك بعد أسبوعين فى المجموعتين المدعمتين وخصوصا المضاف إليها فيتامين C الذى حسن من أمتصاص الحديد مقارنة بالمجموعة الغير مدعمة والكنترول (Basal diet).

زادت كفاءة أسترجاع الحديد وقد زادت أيضا الأستفادة منه إلى ١٨،٤% و ٩،٧ملجم حديد و ١٣،٥٤% و ٦،٨٤ ملجم حديد فى المجموعة المدعمة و المحتوية على فيتامين C و المدعمة فقط على التوالى مقارنتة بالمجموعة المعالجة بعقار كبريتات الحديدوز كان ٢١،٠٧ % و ٢٨،٦ ملجم حديد. أيضا زادت القيمة الحيوية للحديد إلى ٣٣،٩٥ و ٢٣,٩٤ % للمجموعة المدعمة و المحتوية على فيتامين C و المدعمة فقط مقارنتة بالبسكويت الغير مدعم و الكنترول كانتا ٨٩، و ٧،٧٤ % على التوالى. وجد أن تكلفة البسكويت المدعم بالطحال المجفف تزيد عن البسكويت الغير مدعم به وعن البسكويت التجارى (مارى) بنسبة ٥٥،٧ و ٣٩،٦ % على التوالى.