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Evaluation of the effect of fortification with sepia,sardine and salmon as anti-osteoporotic on the general properties of bread rolls

[1]Omnia G. Refaat, [1]Hany G. El-Masry [2]Eman S. Ibrahem And [1]Ola A. Abd El-Khalek

[1]Nutrition and Food Science Dept. Faculty of Home Economics, Helwan University,
[2]Regional Center for Food and Feed, Agriculture Research Center,Giza, Egypt

Abstract

The fortification of main foods is generally accepted as an effective way for providing the daily requirements for a range of vitamins and minerals. The present study was carried out to investigate the acceptability of bread rolls fortified with fish for the prevention of osteoporosis. Four samples of bread rolls were made using fish bone powder at 5% of the total components as follows: the first sample, which is the control sample, the second sample, which contains salmon fish bones powder at 5%, the third sample, which contains sardine fish bones by 5%, and the fourth sample Which contains sepia fish bone powder at a percentage of 5%. Then a sensory evaluation was made for these samples in terms of appearance, internal color, external color, Cells uniformity, taste,smell and general acceptance. The results showed that bread rolls supplemented with sepia fish bone powder are closer to the control sample in properties except for taste, smell and general acceptancein conclusion, three types of fish. The impact of Sibia, Sardine and Salmon fish has been studied on blood stages of calcium, and phosphorus. Measurement of bone mineral content (BMC) and bone mineral density (BMD). Results found that 3 kinds of

fish particularly sibia fish brought about. In addition, a full-size growth in calcium and phosphorus, bone mineral density and bone mineral content. In conclusion,the 3 kinds of fish specifically sibia fish defend rats againstosteoporosis thru their nutrition D, calcium and phosphorus content. So, it could be useful to human beings.

Keywords: Sibia, Sardine, Salmon, Prednisone Acetateas, osteoporotic

Introduction

Fish, which constitutes a major food group in diets throughout the world, contains high levels of n-3PUFAs, high-quality protein, vitamins and essential minerals, and thus may be beneficial to bone health. Some studies have reported that fish consumption can in fact reduce the risk of bone fracture ***(Xia et al.,2012)***.It is shown that BMD was significantly higher among participants living in a fishing village than among those living in a mountain village with less access to fish ***(Calderon-Garcia et al.,2013).*** Furthermore, the effect of fish consumption on bone health may vary among fish species ***(Fan et al.,2013).***

Calcium-fortified products would be helpful in the enhancement of the levels of calcium intake ***(Kim and Mendis, 2006),*** particular for population groups with insufficient intakes of milk and dairy products due to lactose intolerance **(*Jung et al., 2006; Luu and Nguyen, 2009).*** Common food products successfully fortified with calcium in developing countries are including milk and milk products, wheat flour, corn flour, salt, sugar, fats and oils ***(Singh et al., 2007).*** These products are fortified by using commercial calcium salts such as calcium carbonate, calcium citrate and tricalcium phosphate ***(Nemati et al.,2017)*** whereas utilization of natural calcium

sources such as fish bone can be more acceptable by consumers and be more effective in terms of theexistanec of calcium phosphate compound in which is similar to the human bone components ***(Phiraphinyoet al., 2006; Chuamani, 2010 and Hemung, 2013).***

Fish bones have a high Ca content, and huge quantities of this raw material are available as a by-product of the fish industry. Previously,the emphasis has been on producing high quality products from fish by-products by use of bacterial proteases. However, documentation of the nutritional value of the enzymatically rinsed Ca-rich bone fraction remains unexplored ***(Malde et al.,2010a).***

In many countries, large quantities of fish waste and fish by-productsare discarded into the environment and converted into an important of pollution ***(Stevanato et al., 2008).*** In recent years, dried fish bone was used as a feed ingredient in diets for fish and other animals, with a positive effect on feed efficiency and growth compared to traditional diets ***(Toppe et al., 2006).*** Fish meal obtained from whole fish or fish by-products contains approximately 10% minerals, particularly high in calcium and phosphorus, and also represents as a significant source of minerals once included in feed ***(Toppe et al., 2007).*** Anyway, minimal publications are addressed regarding the bioavailability of calcium recovered from fish bone and its potential usability ***(Kim and Mendis, 2006).***

It is concluded that bones from Atlantic salmon and Atlantic cod are suitable as natural Ca sources in e.g. functional foods or as supplements ***(Malde et al.,2010b).***In recent years, emphasis has been put on producing high quality nutritional products from fish by-products by use of enzymes ***(Liaset et al.,2003 and Sandnes et al.,2003).*** The bone fraction, which comprises approximately 10-15% of the total body weight of fish (skin not included) is still regarded as waste. The Norwegian fisheries produce more than 600,000 tons of by-products annually, which is more than 20% of the gross weight of fish caught and farmed in Norway. Most of the byproducts are used

as low-quality raw materials for feed production, and about 180,000 tons are dumped into the sea ***(Malde et al.,2010b).*** Thus, scientific documentation of content and use of various components from marine by-products for human consumption is warranted.

Fish bone has high calcium (Ca) content, and Ca and phosphorus (P) comprise about 2% (20 g/kg dry weight) of the whole fish. The chemical composition of fish bones varies, and in general, oily fish (e.g. salmon) have higher lipid levels, and lower protein and ash levels compared to lean species (e.g. cod) ***(Toppe et al.,2007)***. A recent study in growing pigs has shown that Ca from salmon, cod and saithe bones is absorbed as efficiently as CaCO3***(Malde et al.,2010b).***The study also indicated that fish species and rinsing method may be of importance both for nutritional content and absorption. Ca-fortified foods are likely to play an important role in helping consumers to meet the calcium requirements needed to reduce the risk of osteoporosis. Thus, there is a need for evaluating Ca absorption from different types of fish bone against other commercially available products. ***(Malde et al.,2010b).***

Cuttlebone (CB), otherwise called cuttlefish spine, is an inner shell of marine creatures known as cuttlefish (Sepia), having a place with the phylum mollusca, class cephalopod, arrange Sepiidae***(Zhao et al., 2011 and North et al., 2017).*** Cuttlefish bone is for the most part made out of calcium carbonate. A few tests considerhaving been directed at normal cuttlefish bone as a calcium hotspot for bone substitutes ***(Negm, 2018).*** Cuttlefish bone will in general be utilized and masterminded by various fillers as a marine typical opposing to Osteoporosis ***(Hemmatti et al., 2018).***

Materials and methods

Materials:

Sibia, Sardine and Salmon fish: Egyptian sibia, sardine and salmon fishwere obtained from thelocal markets and its bone were collected and removed for fortification study on the baked products (bread rolls).

Wheat flour:wheat flourwas obtained from thelocal marketsto make thebaked product (bread rolls).

Rats: Fifty adult female albino rats of Sprague Dawley strain weighing(170 ± 10 g) were obtained from Helwan farm for experimental animals, in Cairo, Egypt.

Diet: Casein, vitamins, cellulose, minerals, methionine and choline were obtained from Morgan Company for Chemicals, Cairo, Egypt.

Chemicals: Kits for biochemical analysis were purchased from theBiodiagnostic Company for Pharmaceutical and Chemicals, Dokki, Egypt.

Prednisone Acetate as a source of glucocorticoid was obtained from Pharmacy, Cairo, Egypt.

Methods:

Chemical composition: Protein, calcium, phosphorus, magnesium, zinc and vitamin D content in sibia, sardine and salmon were determined according to the official methods ***(AOAC., 2005).***

Sibia, Sardine and Salmon fish: were dried in the oven for 15 minutes at 40°C, grinded up in a grinder and crushed in a ceramic mortar.

Preparation of Sibia, Sardine and Salmon bone Powder: blocked fish bone was removed from thesibia, sardine and salmon,each one gently washed with distilled water, and dried in free air in order to lose its smell. After drying, the clean fish bone was powdered.

Preparation of fortified baked product (bread rolls): baked product(bread rolls) were prepared according to the procedures

reported by **(Gisslen.,2007)** using bone powder as a fortification by 5% of the total ingredients. The products were prepared in the laboratory of nutrition and food science, faculty of Home Economics, Helwan University.

Experimental Design:

Fifty adult female albino rats were housed in well-aerated cages under hygienic conditions and were fed on a basal diet for one week for adaptation. After this week the rats were divided into five groups as follows:

The first groups (10 rats) were kept as a negative control group and were fed only on a basal diet. The other four groups (10 rats each) were fed on a basal diet containing 100 mg Prednisone Acetate as a source of glucocorticoid/ kg diet for two weeks to induce osteoporosis ***(Liao et al., 2003),*** four rats were selected to insure the induction of osteoporosis by DEXA scan then the osteoporotic group were divided as follow:

The second group served as a positive control group and fed on a basal diet.

The third group was fed on a basal diet supplemented with sibia powder at the level of (5%).

The fourth group was fed on a basal diet supplemented with sardine powder at the level of (5%).

The fifth group was fed on a basal diet supplemented with salmon powder at the level of (5%).

All rats were observed each day. Their feed intake was determined daily and body weights were obtained every week. Feed Efficiency Ratio and body weight gain were calculated according to the method of ***(Chapman et al., 1959).*** At the end of the experiment (8 weeks) the rats fasted for 12 hours, and then were sacrificed under ether anesthesia. Blood samples were collected from the medial

canthus of the eyes of rats by means of fine capillary glass tubes in a centrifuge tube without any anticoagulant and were centrifuged for 20 minutes at 3000 r.p.m. to obtain the serum which was stored at -20°C until used for subsequent analysis.

Four samples of bread rolls were made using fish bone powder at 5% of the total components as follows: the first sample, which is the control sample, the second sample, which contains salmon fish bones powder at 5%, the third sample, which contains sardine fish bones by 5%, and the fourth sample Which contains sepia fish bone powder at a percentage of 5%.

Biochemical analysis:

Serum calcium and phosphorus were determined according to ***(Gindler and King., 1972)*** and***(El-Merzabani et al., 1977),*** respectively. Measurement of bone mineral density (BMD) and bone mineral content (BMC): The BMD and BMC of femur bone were estimated in anesthetized rats using dual energy X-ray absorptiometry (DEXA) according to ***(Gao et al., 2013).***

Organoleptic (Sensory) evaluation:

Sensory evaluation was carried out by (10) panelists from the Department of Nutrition and food science at the Faculty of Home Economics, Helwan university, using a score sheet of 5-points(1=lowest quality to 5=highest quality) according to **(Klein.,1984 and Penfield and Campbell ,1990).**

Bakery products (bread rolls) were evaluated for: appearance ,color (internal/external),celluniformity,taste,odor and overall acceptability.The results for each characteristic were calculated as mean values, analyzed statistically and tabulated.

Statistical analysis:

The obtained results were analyzed according to the SPSS program. ANOVA test was used to compare results among groups and P<0.05 was considered significant ***(SPSS., 1986).***

Results and discussion

Body weight gain and food efficiency ratio (BWG% and FER):

Table 1 indicated significant differences (P ≤ 0.05) inBWG% between the negative (-) control group and tested groups. Rats in groups 2, 3 and 4 significantly (P ≤ 0.05) BWG% differedcompared to those of the negative (-) control. While the mean value of BWG% in group 5 recorded non-significant change as compared to the negative (-) control group. BWG% in groups 2, 3, 4 and 5 were: 16.52 ± 1.50; 21.80 ± 1.22; 23.15 ± 1.48 and 30.61 ± 1.12, respectively vs. 41.05 ± 1.43 for the negative (-) control.Also BWG% in groups 3, 4 and 5 showed significant variations (P ≤ 0.05) as compared to the control “group 2” (21.80 ± 1.22; 23.15 ± 1.48 and 30.61 ± 1.12, respectively vs. 16.52 ± 1.50. Data in this table recorded non-significant changes in BWG% between all treated groups.

The tabulated data revealed that osteoporosis significantly (P ≤ 0.05) altered the FER in rats. Rats in groups1, 3, 4 and 5 significantly (P ≤ 0.05) differed from those of the positive (+) control group. The mean values of FER for groups 1, 3, 4 and 5 were: 0.16 ± 0.137; 0.13 ± 0.004; 0.14 ± 0.007and 0.15 ± 0.009, respectively vs. 0.05 ± 0.003 for the positive (+) control. All treated groups showed non-significant changes in FER as compared to the negative control group.

These results showed a significant decrease ($P \leq 0.05$) in body weight gain and FER of control positive (suffering from osteoporosis) compared to control negative (healthy rat).These results are in agreement with the findings of ***Oliveira et al., (2010)*** and ***Soltan, (2013)*** , who reported that glucocorticoids induced a significantly lower weight gain (-9.7%) compared to the control group. Meanwhile, rat's administration diet supplemented with 20% sardine fish recorded a significant increase in final body weight and body weight gain compared to the positive control group. These results are in accordance with the results obtained by ***Gouda, (2012),*** who reported that control positive (osteoporotic rats) showed a significant decrease in body weight gain. The decrease in body weight gainmay be due to high dosesof cortisone and long-term.

These results agreed with ***EL- Sayed, (2017)*** showed that Rats who were fed on a basal diet containing fish as a source of protein recorded higher feed intake and BWG value than other treated groups.Feed intake and BWG were increased in the negative control group than in the positive control group. On the other hand a treated rat with fish illustrated a significant decrease in BWG% when compared with the negative control group.

Daidj and Lamri-Senhadji, (2021) observed that the sardine by-product oil and sardine fillet oil groups showed similar significant decreases in body weight, weight gain, and food intake in the obese control group. Moreover, obese rats consuming fillet and by-product sardine oils had negative FER values compared with control obese and normal rats; FER ratios indicate the animal's ability to transform energy consumed into body mass ***(De Sibio et al., 2013).*** Fatty fish such as sardines help the body burn fat in addition to generating a feeling of satiety. This satietogenic effect may explain the decrease in food intake in obese groups consuming sardine oil and explains the negative FER values.

Calcium and phosphorus:

Table 2indicated that rats in groups1, 3, 4 and 5 had significant ($P \leq 0.05$) differences in serumcalcium as compared to the positive (+) control group. The mean values of calcium for groups 1, 3, 4 and 5 were: 11.71 ± 0.12; 12.18 ± 0.37; 11.74 ± 0.13and 13.08 ± 0.27, respectively vs. 8.16 ± 0.11 for the positive (+) control also group 5 recorded significant ($P \leq 0.05$) increase in serum calcium, as compared to the negative (-) control (13.08 ± 0.27vs. 11.71 ± 0.12respectively) and no significant differences ($P \leq 0.05$) were recorded of serum calciumbetween groups 1, 3 and 4.

Also the data revealed that rats in groups 1, 3, 4 and 5 had significant ($P \leq 0.05$) levels of serumphosphorus that differed from those of the positive (+) control group. The mean values of phosphorus for groups 1,3,4 and 5 were: 13.40 ± 0.21; 12.18 ± 0.37; 12.72 ± 0.13and 12.91 ± 0.17, respectively vs. 9.38 ± 0.15 for the positive (+) control, also groups 3 showed significant decrease ($P \leq 0.05$) as compared to the negative (-) control (12.18 ± 0.37; 12.72 ± 0.13 vs. 13.40 ± 0.21 respectively) and no significant differences ($P \leq 0.05$) were recorded of serum phosphorusbetween groups 1 ,4 and 5.

De Nijs ., (2008) stated that bone loss is one of the most important side effects of glucocorticoid use, even in low doses. The main effect of glucocorticoids on bone is the inhibition of osteoblast function, leading to a decrease in bone formation. Also nongenomic effects (mediated by glucocorticoid interactions with biological membranes, either through binding to membrane receptors or by physicochemical interactions) may have a role in the pathogenesis of glucocorticoid-induced osteoporosis (GIOP). in addition secondary hyperparathyroidism induced by the negative balance of calcium due to inhibition of absorption and increase of excretion is an important systemic mechanism of GIOP ***(Kaneko and Kawai .,2011).***

The anti-inflammatory effects of *n*-3 FAs are well-known. Recently, a promising association between higher *n*-3 FA intake andimproved bone turnover markers and bone mineral density (BMD)inhumans has been reported ***(Coetzee et al., 2007).***One of themechanisms by which dietary n-3 fatty acids reduce bone loss inovariectormized mice is by inhibition of osteoclast generation andactivation ***(Matsushita et al.,2008).***

McManus et al., (2010) stated that "seafood is a rich source of both calcium and Vitamin D, important bone-building micronutrients.High intake of sea fish is independently associated withgreaterbonemass and lower the osteoporosis risk in women, especially thoseconsuming more than 250 grams per week of seafood. An abundanceof nutrients can be found in mackerel, whichincludecalcium,potassium, selenium and magnesium These nutrientshelpmaintainproper function of the body and are importantfortheheart,bonesandteeth, nerves and muscles, and propermetabolicfunction.Mackerelisa good source of vitamins like niacin(vitaminB3),choline, folate, vitamin E, vitamin D, vitaminA,vitaminK,vitaminC and vitamin B12.

Calcium sources for these supplements include calcium carbonate ores, animal skeletons, seashells, and crustaceans. Therefore, other resources including marine resources, have gained attention due to their high safety and biological activity in recent years ***(Martiniakova et al., 2022).*** Similar results have been obtained in the study of ***Brennan et al. (2017)*** using a calcium-rich marine multimineral complex which significantly preserved trabecular bone microarchitecture and slowed the onset of bone loss in comparison with calcium carbonate.

Calcium, vitamin D and parathyroid hormone are basic controllers of bone redesigning ***(Lu et al., 2013).*** Serum calcium and phosphorus are ordinarily utilized as biochemical markers of bone

development and building. The abatement in serum levels of calcium and phosphorus in rats experiencing osteoporosis actuated as detailed in this examination was like the past report ***(Coxam, 2005).*** The diminished serum calcium levels were additionally answered to be because of estrogen inadequacy in rats experiencing osteoporosis initiated ***(Choi and Seo, 2013).***

The previous results were in line with***Soltan, (2013)*** who showed that all treatments showed a significant increase ($p \leq 0.05$) in serum calcium and phosphorus. These results may be due to sardine fish having higher calcium content and being easily absorbed by the body. ***Larsen et al. (2000)*** reported calcium from fish would be easily absorbed by the body and the intake of small fish with bones could increase calcium bioavailability. ***EL- Sayed, (2017)*** observed that fish meat caused a significant increase ($P \leq 0.05$) in serum Ca and P, when contrasted with the positive control group.

Hemmattiet al., (2018) announced that cuttlebone is a natural compound with a high level of CaCO3, it tends to be utilized and figured by various fillers as a marine natural anti-Osteoporosis. ***Negm, (2018)*** showed that feeding rats with powder of cuttlefish bone caused a significant increase ($P \leq 0.05$) in serum Ca and P, when contrasted with the positive control group. The author of this study recommended using powder of cuttlebone for postmenopausal women suffering from osteoporosis.

Bone mineral density (BMD) and bone mineral content (BMC):

Table 3 revealed that osteoporosis significantly ($P \leq 0.05$) altered the bone mineral density (BMD) and bone mineral content (BMC) in female rats.

Rats in groups 1, 3, 4 and 5 had bone mineral density (BMD) that differed significantly ($P \leq 0.05$) from those of the positive (+) control. Mean values of bone mineral density (BMD) for groups 1, 3, 4 and 5

were: 0.181 ± 0.010; 0.122 ± 0.021; 0.138 ± 0.005 and 0.163 ± 0.007, respectively vs. 0.076 ± 0.011 for the positive (+) control.

Also rats in groups 1, 4 and 5 had bone mineral content (BMC) that differed significantly ($P \leq 0.05$) from those of the positive (+) control. Mean values of bone mineral content (BMC) for groups 1, 4 and 5 were: 0.232 ± 0.004; 0.211 ± 0.008 and 0.228 ± 0.006, respectively vs. 0.201 ± 0.012 for the positive (+) control. But no significant differences ($P \leq 0.05$) were found between groups 2 and 3 for bone mineral content (BMC).

The Glucocorticoid has harmful effects on bonedensity ***(SedoSarkis et al., 2012).*** Glucocorticoid induced osteoporosis leads to a suppression of bone formation by decreasing thenumber and function of osteoblast and induced bone loss ***(DiMunno and DelleSeide, 2006).*** There are many reported decreasing BMD andBMC in osteoporosis disease ***(Wu et al., 2001 and Matsumoto et al., 2002).***These results are in agreement with the findings of ***Soltan, (2013)*** showed that the mean BMD and BMC of osteoporotic rats fed a diet supplemented with 20 %sardine fish.The increases in BMD and BMC due to increases in calcium and phosphorus in the diet lead to increases inostoblast cells which lead to increases in bone formation. The previous results were in agreement with ***Farina et al., (2011)*** observed that Fish consumption may protect against bone loss. Also, ***Luo et al., (2015)*** showed that salmon calcitonin treatment was effective in delaying the process of disc degeneration in OVX rats. ***Negm, (2018)*** showed that bone mineral (content and density) significantly ($P \leq 0.05$) increased in rats fed a basal diet and supplemented with powder of cuttlefish bone.

Sensory evaluation for bread rolls:

Table 4 showed significant differences ($P \leq 0.05$) in the appearance of bread rolls between the control group and tested groups (except for bread rolls of sibiafish (group 4). values for appearance in groups 2 and 3 were: 2.50 ± 0.38 and 2.73 ± 0.29, respectively vs. 4.65 ± 0.10 for the control but no significant differences were found between bread rolls of salmon fish(groups 2) and bread rolls of sardine fish(groups 3).

Likewise, the Interior color, Exterior color and Cells uniformity ofbread rolls followed the same pattern as those of the appearance.

The data also showed significant differences ($P \leq 0.05$) in thetasteof bread rollsbetween the control group and all tested groups .values for taste in groups (2,3 and 4) were: 2.00 ± 0.25; 2.39 ± 0.27 and 3.36 ± 2.69, respectively vs. 4.57 ± 0.11 for the control but no significant differences were found between groups 2 and 3.

Likewise, the odor and total acceptance of bread rolls followed the same pattern as those of the taste.

The bread rolls of Sibia fish powder had ahigher appearance, interior color, exterior color, cells uniformity, taste, odor and total acceptance than the bread rolls of salmon and sardine fish powder.

Table (1): Effect of Sibia, Sardine and Salmon fish on body weight gain and food efficiency ratio (FER) in female rats with (BWG) osteoporosis.

Parameters / Groups	BWG%	FER
G1: Control (-ve)	41.05 ^{a} ±1.43	0.16 ^{ab} ±0.137
G2: Control (+ve)	16.52 ^{c} ±1.50	0.05 ^{c} ±0.003
G3: 5% Salmon	21.80 ^{bc} ±1.22	0.13 ^{ab} ±0.004
G4: 5% Sardine	23.15 ^{bc} ±1.48	0.14 ^{ab} ±0.007
G5: 5% Sibia	30.61 ^{ab} ±1.12	0.15 ^{b} ±0.009

Values are expressed as means ± SD

Values at the same column with different letters are significantly different at P≤0.05.

Table(2): Effect of Sibia, Sardine and Salmon fish on levels of serum calcium and phosphorus in female rats with osteoporosis.

Parameters / Groups	Ca mg/dl	P mg/dl
G1: Control (-ve)	11.71^{b} ±0.12	13.40^{a} ±0.21
G2: Control (+ve)	8.16^{c} ±0.11	9.38^{c} ±0.15
G3: 5% Salmon	12.18^{b} ±0.37	12.18^{b} ±.37
G4: 5% Sardine	11.74^{b} ±0.13	12.72^{ab} ±-.13
G5: 5% Sibia	13.08^{a} ±0.27	12.91^{a} ±0.17

Values are expressed as means ± SD

Values at the same column with different letters are significantly different at P≤0.05.

Table (3): Effect of Sibia, Sardine and Salmon fish on bone mineral density (BMD) and bone mineral content (BMC) infemale rats with osteoporosis.

Parameters / Groups	BMD g/cm^{-2}	BMC g/cm
G1: Control (-ve)	0.181^{a} ±0.010	0.232^{a} ±0.004
G2: Control (+ve)	0.076^{f} ±0.011	0.201^{c} ±0.012
G3: 5% Salmon	0.122^{d} ±0.021	0.209^{c} ±0.009
G4: 5% Sardine	0.138^{c} ±0.005	0.211^{b} ±0.008
G5: 5% Sibia	0.163^{b} ±0.007	0.228^{ab} ±0.006

Values are expressed as means ± SD

Values at the same column with different letters are significantly different at $P \leq 0.05$.

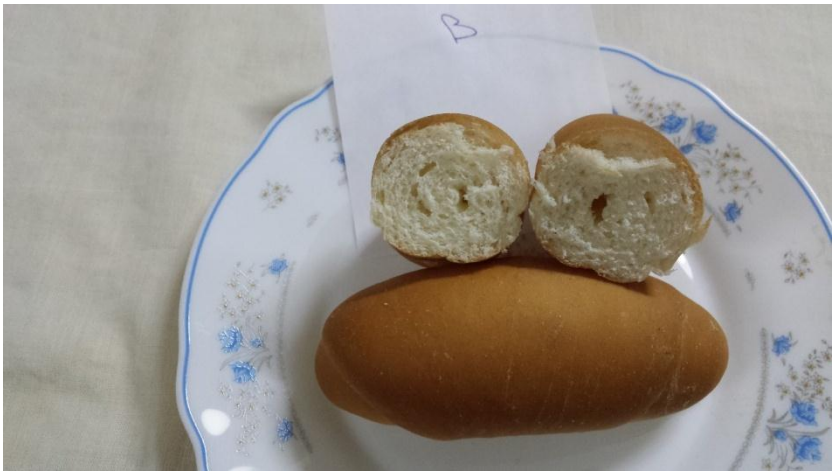
Table (4): Effect of Sibia, Sardine and Salmon fish on Sensory evaluation for bread rolls.

	Appearance (5)	Interior color (5)	Exterior color (5)	Cells uniformity (5)	Taste (5)	Odor (5)	Total Acceptance (5)
G1: Control	4.65±0.10^{a}	4.78±0.09^{a}	4.57±0.13^{a}	4.23±0.18^{a}	4.57±0.11^{a}	4.55±0.13^{a}	4.63±0.17^{a}
G2: Salamone	2.50±0.38^{b}	2.65±0.32^{b}	2.36±0.34^{b}	3.05±0.35^{b}	2.00±0.25^{c}	2.26±0.32^{c}	2.34±0.31^{c}
G3: Sardine	2.73±0.29^{b}	2.76±0.20^{b}	2.65±0.25^{b}	3.26±0.28^{ab}	2.39±0.27^{c}	2.15±0.21^{c}	2.31±0.24^{c}
G4: Sibia	4.62±0.15^{a}	4.36±0.20^{a}	4.50±0.15^{a}	4.13±0.14^{a}	3.36±2.69^{b}	3.36±0.28^{b}	3.76±0.23^{b}

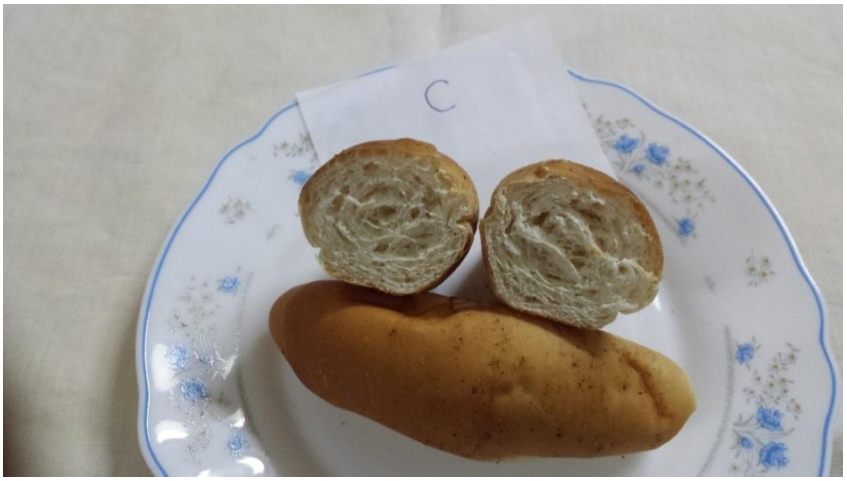
Values are expressed as means ± SD

Values at the same column with different letters are significantly different at $P \leq 0.05$.

(control)



(Sibia)



(Sardine)

(Salmon)

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Omnia G. Refaat, Hany G. El-Masry , Eman S. Ibrahem
And Ola A. Abd El-Khalek

تقييم تأثير التدعيم بأسماك السيبيا والسردين والسلمون كمضادات لهشاشة العظام على الخصائص العامة لخبز الفينو

أمنية جلال رفعت ، هانى جابر المصرى، ايمان سامى ابراهيم علا على عبد الخالق

الملخص العربى

تدعيم الأطعمة الرئيسية بشكل عام يعتبرطريقة فعالة لتوفير المتطلبات اليومية لمجموعة من الفيتامينات والمعادن. تهدف الدراسة الحالية الى معرفة مدى قبول خبز الفينو المدعم بعظام الأسماك للوقاية من هشاشة العظام. تم عمل أربع عينات من خبز الفينو باستخدام مسحوق عظم السمك بنسبة 5٪ من إجمالي المكونات كما يلي: العينة الأولى وهي العينة الضابطة والعينة الثانية التي تحتوي على مسحوق عظام سمك السلمون بنسبة 5٪ والعينة الثالثة والتي تحتوي على مسحوق عظام سمك السردين بنسبة 5٪. ، والعينة الرابعة التي تحتوي على مسحوق عظم سمك السيبيا بنسبة 5٪. ثم تم التقييم الحسي لهذه العينات من حيث المظهر واللون الداخلي واللون الخارجي والمسام والطعم والرائحة والقبول العام. أظهرت النتائج أن خبز الفينو المضاف إليه مسحوق عظام سمك السيبيا أقرب إلى العينة الضابطة في الخواص باستثناء الطعم والرائحة والقبول العام.وتم دراسة تأثير اسماك السيبيا والسردين والسلمون على كالسيوم وفسفور الدم ايضا بالأضافة الى قياس محتوى وكثافة العظام من الأملاح المعدنية واظهرت النتائج أن الثلاث انواع من الأسماك وخاصة السيبيا كانت لها نتيجة ايجابية بالأضافة الى زيادة كاملة فى الكالسيوم والفسفور وفى محتوى وكثافة الاملاح المعدنية فى العظام. وفي الختام ، الثلاثة أنواع من الأسماك خاصة سمك السيبا احدثت تراجع للفئران من حدوث هشاشة العظام وذلك لمحتواها من فيتامين د والكالسيوم والفسفور لذلك فهى مفيدة للبشرية.

الكلمات المفتاحية : سيبيا ، سردين ، سلمون ، بريدنيزون اسيتات ، هشاشة العظام.