Food and Nutrition Sciences, 2021, 12, 719-731
https://www.scirp.org/journal/fns
ISSN Online: 2157-9458
ISSN Print: 2157-944X

Utilization of Small Size Bolti (*Talibia nilotica*) and Sardine (*Sardina pilchardus*) Fish in Preparing Canned Weaning Food Purees

Faten Farouk Abdel-Salam[1*], Nadia A. Abd-El-Aziz[2], Saadia M. Hashem[1]

[1]Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt
[2]Meat and Fish Technology Research Department, Food Technology Research Institute, Agriculture Research Center, Alexandria, Egypt
Email: *faten.mohamed@alexu.edu.eg

How to cite this paper: Abdel-Salam, F.F., Abd-El-Aziz, N.A. and Hashem, S.M. (2021) Utilization of Small Size Bolti (*Talibia nilotica*) and Sardine (*Sardina pilchardus*) Fish in Preparing Canned Weaning Food Purees. *Food and Nutrition Sciences*, **12**, 719-731.
https://doi.org/10.4236/fns.2021.127054

Received: June 4, 2021
Accepted: July 12, 2021
Published: July 15, 2021

Abstract

Utilize small size of bolti and sardine fish in preparing fish based weaning foods rich in protein, essential amino acids, fat high in omega 3 fatty acids, minerals and vitamins was investigated. The proximate composition, nutritional value, physical and sensorial properties were evaluated, The results of the chemical composition showed that the moisture content of fish based weaning food purees ranged from 67.73% to 72.05%. On dry weight basis, the five prepared formulations considered rich in protein (37.39% - 44.86%), fat (26.55% - 30.43%), ash (6.53% - 12.23%) and low in carbohydrates (20.70% - 22.18%). Using fish bones with muscles in preparing weaning food puree caused a marked rise in its content of Ca, P, Fe, and Zn levels especially in purees formulated from bolti. Weaning food purees containing sardine fish rich, in fat, were higher in vitamin A and D than those formulated from bolti one. Palmitic acid (C16:0), stearic acid (C18:0), and myristic acid (C14:0) represented the major saturated fatty acids in the prepared formulations. Weaning food purees containing sardine fish had relatively higher levels of sulfur-containing amino acids and slight lower values of lysine, alanine and glycine than these including bolti fish. The In vitro protein digestibility index (IVPDI) of the different formulations was found to be 100%. The visual colour of such products can be described as yellowish. Except hardness, the other texture characteristics; cohesiveness, springiness, gumminess, and chewiness of the weaning food purees did not significantly change. The children's mothers accepted the appearance, flavor, and mouth feel of all weaning food purees prepared in this study.

Keywords

Weaning Foods, Protein Digestibility, IVPDI, Fish Based Food Products,

Children Nutrition

1. Introduction

Through the first month of life, an infant is fed on breast milk or formula. After four to six months of age, the requirements of child nutrition are increased. Therefore, the use of supplementary feeding, weaning foods, is necessary. Weaning has been defined as the process of expanding the diet to include foods and drinks other than breast milk or infant formula. Hence, most important aspect of weaning is the introduction of solid foods, and not to stop the breast milk. Most mothers give their babies at the age of about 6 months some diluted cow's milk, biscuits, bananas, cereal products, meat and fish [1].

Food and Agriculture Organization (FDA) and Integrated Child Development Scheme have advised developing weaning foods from the locally available foods to avoid children malnutrition [2] [3]. These foods are introduced in the form of gruel or paste free from fiber materials to avoid diarrhea and based on hunger rather than fixed hour. Fibers lowered food energy density and phytates reduce absorption of micronutrients [4].

Nutritional quality of weaning foods based on their formula ingredients. It should provide necessary extra energy and micronutrients. Cereal, vegetables, meat, eggs, fish and their mixture can use to prepare such products. On the commercial scale, such weaning products are available in different varieties ranging from dry to sterilized canned puree form [5]. Most of the weaning foods are semisolid with soft texture. The flow characteristics of infant foods must be thick enough to stay in the spoon, but not too thick as to make swallowing difficult [6] [7].

Generally using supplementary feeding in this critical stage of child life must concern on providing optimal caloric content, protein containing balanced amino acids composition and macronutrients. Protein is important to ensure adequate growth and organs development. Carbohydrate is essential to provide calories. Also, lipids are the primary source of caloric intake primarily in the form of triglycerides, exogenous cholesterol, essential and free fatty acids. Nutrient elements such as Ca, P, Fe, Zn, and Mg are important to avoid diseases such as rickets, Fe—deficiency and abnormal development. Also, water and fat soluble vitamins play an essential role in the growth and development of skin, eyes, bones, and pulmonary epithelium [8].

[9] explained that the infant digestive system cannot fully hydrolyze proteins during the first two years of life and the use of predigested foods, could be good for these age groups.

Therefore, the aim of this study was to utilize the previous species of fish in preparing new fish based formulating weaning foods rich in protein and essential amino acids, fat high in omega 3 fatty acids, minerals, and vitamins after removing fish odour and mixing with other ingredients. The proximate composition, nutritional value, physical and sensorial properties of these formulations were evaluated after preparing in sterilized puree form in small glass jars to introduce as homogenized weaning foods.

In Egypt, a large amount of small size underutilized bolti (*Talibia nilotica*) and sardine (*Sardina pilchardus*) fish are found in fish market in the first and the end of their maximum production seasons. It is considered an important source of protein, fat, and minerals. Generally, fish muscle is the main component of many homogenized weaning foods. Fishbone is also rich in minerals especially Ca and P. It is technically possible to process the flesh of some fish with bone by careful prior homogenization and thus raise their mineral content [10].

2. Material and Methods

2.1. Material

Small fish sizes (20 - 25 fish/Kg) of bolti (*Talibia nilotica*) and sardine (*Sardina pilchardus*) were obtained at the beginning of 2020 from Alexandria fish market, Alexandria, Egypt. Fresh onions, refined fine iodized common salt, unsalted butter 100% cow milk (Lurpak butter), instant whole milk powdered, fresh celery, food grade corn starch, 22% tomato paste,5% vinegar and small glass jars, 250 g capacity, were obtained from local market, Alexandria city, Egypt. All reagents and chemicals used in this study were an analytical grade.

2.2. Methods

2.2.1. Technological Methods

Weaning food formulations: Each of bolti and sardine fish species was cleaned and washed with water. The head, tail and fins of each fish were removed before soaking in water solution containing 2% common salt and 2% vinegar for nearly 5 - 10 min to remove the fishy odor then washed by running water. Five samples of minced fish were prepared using fish muscles and/or fish muscles with their bones, whole fish. The different samples were bolti muscles (F1), bolti muscles with its bones (F2), sardine muscles (F3), sardine muscles with its bones (F4) and a mixture of 1:1 w/w of muscles of bolti and sardine (F5). Each one of the above samples was minced 3 times through Luska hand mincer (particle size 0.5 cm.), then cooked at 96˚C for 15 min in 100% distilled water in water bath with continuous stirring to get puree structure before adding in weaning food formulations at 24% wet weight basis as shown in **Table 1**. Weaning foods of each formula was packed in glass jars, well closed with tinplate covers and sterilized at 121˚C for 55 min in a vertical batch steam retort, then cooled in a water bath to room temperature (20˚C ± 2˚C).

2.2.2. Analytical Method

1) Physicochemical properties: The colour values, lightness (L*), redness (a*) and yellowness (b*), of weaning food samples were evaluated using a Hunter Lab Ultra Scan, VIS model, colorimeter (USA). The instrument was standardized during each sample measurement with a black and white tail (L* = 94.1, a*

Table 1. Ingredient and percentages used for weaning food formulation.

Ingredients	Percentage in weaning foods
Fish puree	24.0
Starch	6.0
Butter	5.0
Powdered milk	12.0
Tomato concentrate	4.0
Onion	4.0
Celery	2.0
Salt	1.0
Water (distilled)	42.0

= 1.12, b* = 1.26). Mean of five readings of each colour index of Hunter scale (L*, a*, b*) were recorded [11]. Texture Profile Analysis (TPA) of weaning food was performed using TA-XT 2 Texture meter (Texture Pro CT3 V1.2, Brookfield, Middleboro, USA) as described by [12]. Force time deformation curves were obtained during applying a 5 kg load cell, at a 1 mm/s cross head speed. The following texture attributes were calculated; hardness, cohesiveness, springiness, gumminess and chewiness.

2) Chemical analysis

a) Proximate composition: Moisture, crude protein, crude fat and ash contents of weaning foods were determined according to [13] while carbohydrates were calculated by difference.

b) Amino acids analysis and nutritional value: Amino acids in acid hydrolysate of weaning foods samples were analyzed using the high performance Amino Acid Analyzer (Biochrom 30) according to the method described in [14].

In vitro protein digestibility index (IVPDI) was determined according to [15] using pepsin followed by pancreatin digestion procedures.

Computed protein efficiency ratio(C-PER) and computed biological value of protein (C-BV) were calculated according to [16] using the following regression equations:

i) (C-PER):

$$\text{PER}_A = -0.684 + 0.456\ \text{Leu} - 0.047\ \text{Prol}$$

$$\text{PER}_B = -0.468 + 0.435\ \text{Leu} + 0.105\ \text{Tyr}$$

$$\text{PER}_C = -1.816 + 0.435\ \text{Meth} + 0.780\ \text{Leu} + 0.211\ \text{Hist} - 0.944\ \text{Tyr}$$

The mean of these equations was taken as C-PER value.

ii) C-BV (%) = 39.55 + 8.89 Lysine.

The total calorie (energy) content of each weaning food formula was calculated by multiplying the protein and carbohydrates value by a factor of 4 and the fat value by 9 [17]. Also the percentage protein-calorie to total one of each formulation was measured.

iii) Fatty acids profile: Fat of weaning food was extracted and fatty acids methyl esters were prepared (AOAC, 2000) before analysis by gas chromatographic analysis using ACME model 6100 GC (Young LIN Instrument Co., Korea) fitted with a split injector and FID detector. Nitrogen was used as the carrier gas with a flow rate of 0.5 ml/min. The component were separated on 30 m SP-2380 fused—silica capillary column with 0.25 mm i.d. and 0.2 µm film thickness (Supelco, Belleonte, PA) and the detector temperature was set at 260˚C. The injector temperature was set at 220˚C and in split mode (split ratio 1:80). The column was initially maintained at 140˚C for 5min, and the temperature was subsequently increased to 240˚C at rate of 4˚C/min [18].

iv) Minerals determination: Ca, Fe, P and Zn were determined using inductively coupled plasma atomic emission spectroscopy (ICP-OES) according to standard method US EPA Meth d 200.7 and US EPA Method 6010 C.

v) Vitamins: Vitamin A and D were determined by HPLC System Controller (SCL-6A) using a Shimadzu CTO 6-A column supplies with a SPD-6AV detector (Japan), under high-pressure solvent delivery unit (LC-20AD) according to [13]. A sample volume of 20 µl was run at a flow rate of 2 ml/min for15 min at 20˚C. Vitamin A and vitamin D were identified and quantified by comparing their retention times to known previously injected standards.

2.2.3. Sensory Evaluation

The prepared fish based weaning food purees were subjected for the sensory evaluation using the following questionnaire to record the response of ten of the mothers of children in agriculture collage pre-schooling house, Alexandria, Egypt.

1) How did you like the puree?

A) Like B) OK C) Dislike

2) According to your acceptability, describe each of the following characteristic; appearance, flavor, feel in mouth and easy to use of the purees as good, fair or poor.

2.2.4. Statistical Analysis

Data of proximate analysis and physicochemical properties were statistically analysied and expressed as Mean ± Standard deviation using the software Graphpad Insat 2000 version.

3. Results and Discussion

3.1. Chemical Composition

3.1.1. Proximate Composition

Results in Table 2 showed that moisture content of fish based weaning food purees ranged from 67.73% to 72.05%. It was significantly higher in F1, F4 and F5 than F2 and F3 formulations. This means that each of fish species, presence or absence of bones with fish muscles, fish tissues, affected the moisture value of purees. It is known that fish species high in fat content, such as sardine contains low moisture value than those rich in protein and low in fat as bolti one. Also, fish bones have lower moisture level than fish muscle in the same species [19].

On dry weight basis, the five prepared weaning food purees considered rich in protein (37.39% - 44.86%), fat (26.55% - 30.43%), ash (6.53% - 12.23%) and low in carbohydrates (20.70% - 22.18%), **Table 2**. Also, the total calories of the different formulations varied from 492.88 to 512.15 Kcal/100g of food. The percent protein derived calories were ranged from 29.20 to 35.46% among the different puree formulations. This means that the prepared fish based weaning food purees in this study is adequate in the protein requirement and in conformity with the specifications of world standards weaning foods. According to [2] [20] weaning foods should had 20%protein, up to 10% fat, 90 - 102 Kcal/Kg of child weight, more than 7.1% protein calorie and 30 to 50% fat calorie from total calories requirement. [21] showed that the content of protein and carbohydrates increased with age stage contrary to the fat content which decreased, the percentage of compliance with the protein Dietary Recommended Intake (DRI) increased from birth to 12 months of age from 25% to 37%, contrary to what occurs with fats and carbohydrates, up to more than 50% of the DRI for protein and carbohydrates but less than 30% of the daily recommended fat intake.

The commercial weaning foods including fruit puree presented higher content of carbohydrates than the vegetable, meat and fish ones, which is not surprising if it is considered the natural starch content of these products and the natural sugar from fruits [22].

As seen from **Table 2**, weaning food purees containing bolti fish was rich in protein, lower in fat and ash contents than that formulated from sardine tissues. F5 having 1:1 w/w mixture of muscles of both fish species considered higher in protein, lower in fat and moderate in ash levels comparing with others formulations. Using fish muscles and bones caused a significant decrease in protein and an increase in ash contents of weaning food.

According to [23] fish muscle is an important source of protein and mineral content. Also fishbone is a rich source of calcium (Ca) and phosphour (P), both are essential for optimal bone mineralization. [24]

3.1.2. Mineral Content

It is clear from the data in **Table 2** that using fish bones with muscles in preparing weaning food puree caused a marked rise in its content of Ca, P, Fe and Zn levels especially in purees formulated from bolti than sardine fish. In contrast, purees containing sardine fish muscles had higher level of Ca and P, lower values of Fe and Zn than those having bolti muscles. According to [10] mineral content in fish depends on species, sex, biological cycle, ecological factors and the part of the fish which is analyzed. From nutritional point of view, the same amount of Ca and P (1/1) should be ingested; although a molar Ca/P ratio of 1/1.5 is acceptable, injurious effects appear when this relation is inverted (1/2) [25]. It can be noticed from **Table 2**, that Ca was found in highest concentration in the five prepared weaning foods purees followed by P, Fe and Zn respectively. The Ca/P ratio was 1.28, 1.5, 1.3, 1.22 and 1.36 in F1, F2, F3, F4 and F5 weaning food purees respectively. This means that this ratio in the five prepared weaning purees are acceptable and without injurious effects. The recommended level of Ca, P, Fe and Zn for children are 341.2, 281.2. 8.5 and 3.7 mg [26] and [27]. More than these levels of such minerals were present in the five prepared weaning purees in this study.

3.1.3. Vitamin A and D

Data in Table 2 showed also that weaning food purees containing sardine fish rich, in fat, was higher in vitamin A and D (762.715, 843.087 and 738.392, 206.302 μg/100g respectively) than those formulated from bolti one low in fat and rich in protein. Both vitamins were found in considerable levels in F5 puree containing 1:1 w/w mixture of bolti and sardine muscles. Using sardine or bolti bones, F2 and F4, lowered from vitamin D level. The same observation was noticed in vitamin A in F2 (355.520 μg/100g) compared with F1, free from bolti fish bone (472.011 μg/100g). In contrast, F4 puree more vitamin A than that of F3, sardine bone free. This is an indication that the levels of both vitamins are related with the level of fat in such tissues. Generally, the levels of both vitamins in the five prepared purees in this study were higher than that recommended by [26]. The recommended level is 300 IU for vitamin A and 5 IU for vitamin D.

3.1.4. Fatty Acid Profile

Table 3 summarized the fatty acid profile (g/100g) of the five fish based weaning

Table 2. Proximate composition, some minerals and vitamins A &D of fish based weaning food puree.

Components	Fish based weaning food purees*				
	F1	F2	F3	F4	F5
1-Moisture	72.05 ± 1.00[a]	67.96 ± 0.95[b]	67.73 ± 0.6[b]	71.02 ± 1.0[a]	71.27 ± 1.1[a]
2-Proximate composition (%) On dry weight basis					
Crude Protein	44.86 ± 1.11[a]	43.27 ± 1.00[b]	37.39 ± 1.5[c]	38.07 ± 1.04[c]	44.00 ± 2.63[a]
Crude fat	26.55 ± 1.13[c]	27.27 ± 1.1[bc]	30.43 ± 1.0[a]	28.36 ± 1.00[b]	27.01 ± 0.98[c]
Ash	6.53 ± 0.50[d]	8.64 ± 0.25[c]	10.00 ± 1.0[b]	12.23 ± 1.07[a]	8.30 ± 0.20[c]
Carbohydrates**	22.06	20.82	22.18	21.34	20.70
Total calories	506.63	501.79	512.15	492.88	501.89
Percentage of protein calories to total cal.	35.46	34.49	29.20	30.89	35.06
Minerals (mg/100g)					
Calcium (Ca)	436.67	1277.42	623.24	710.78	534.34
Phosphours (P)	340.91	850.98	467.47	583.68	398.58
Ca/P ratio	1.28	1.5	1.3	1.22	1.36
Iron (Fe)	17.86	25.64	11.37	13.39	14.90
Zinc (Zn)	10.73	7.76	4.19	5.96	7.41
Vitamin A (μg/100g)	472.011	355.520	762.715	843.087	620.434
Vitamin D (μg/100g)	133.422	45.622	738.392	206.302	429.857

*Bolti muscles (F1), bolti muscles with its bones (F2), sardine muscles (F3), sardine muscles with its bones (F4) and a mixture of 1:1 w/w of muscles of bolti and sardine (F5). **Calculated by difference. Different letters in rows indicate significant different values at $P < 0.05$.

Table 3. Fatty acid profile of fish based weaning food puree.

Fatty acid %	Fish based weaning food puree*				
	F1	F2	F3	F4	F5
Saturated fatty acids (SFA)					
Caprylic acid (C8:0)	0.56	0.55	0.36	0.56	0.41
Capric acid (C10:0)	1.74	2.09	1.19	1.74	1.45
Lauric acid (C12:0)	2.74	2.06	2.21	2.74	2.43
Myristic acid (C14:0)	11.18	9.13	10.15	11.18	10.64
Palmitic acid (C16:0)	33.02	32.66	33.87	33.02	33.62
Stearic acid (C18:0)	12.44	13.52	13.39	12.44	13.03
Arachidic acid (C20:0)	0.44	0.55	0.44	0.44	0.41
Total (Σ SFA)*	**62.12**	**60.56**	**61.61**	**62.12**	**61.99**
Mono unsaturated fatty acids (MUFA)					
Myristolic acid (C14:1n9c)	1.01	1.02	0.88	1.01	0.92
Palmitolic acid (C16:1n9c)	3.97	3.10	3.36	3.97	3.73
Eicosenoic acid (C20:1)	0.89	1.01	0.15	0.89	0.47
Oleic acid (C18:1n9c)	26.28	27.59	28.41	26.28	27.39
Total (Σ MUFA)%	**32.15**	**32.72**	**32.80**	**32.15**	**32.51**
Poly unsaturated fatty acids (PUFA)					
Linoleic acid (C18:2n6c)	2.64	1.53	2.51	2.64	2.42
Linolenic acid (C18:3n3)	0.61	1.88	0.77	0.61	0.63
Total (Σ PUFA)%	**3.25**	**3.41**	**3.28**	**3.25**	**3.05**
saturated:unsaturated ratio	1:0.56	1:0.59	1:0.58	1:0.56	1:0.57

*Bolti muscles (F1), bolti muscles with its bones (F2), sardine muscles (F3), sardine muscles with its bones (F4) and a mixture of 1:1 w/w of muscles of bolti and sardine (F5).

food purees. Palmitic acid (C16:0), stearic acid (C18:0), and myristic acid (C14:0) represented the major saturated fatty acids in the five weaning food purees. Meanwhile the minor ones were lauric acid (C12:0) and capric acid (C10:0). The others saturated fatty acids were found in very low concentrations. The main sources of short chain fatty acids are butter and powder whole milk which are used as an ingredient at 5% and 12% during preparing the purees. Among monounsaturated fatty acids, oleic acid (C18:1) was the predominate one followed by palmitolic acid (C16:1), myristolic acid (C14:1) and eicosenoic acid (C20:1). The last two fatty acids were found in low values. Linoleic acid (C18:2) considers the main polyunsaturated fatty acid in the five purees. It is ranged from 1.53% - 2.64%. Except in F2 puree which is made from whole bolti fish, linolenic acid (C18:3) was present in low level, less than 1%. Generally, it can be noticed that fat of the prepared five weaning food purees consisted mainly of saturated fatty acids(more than 60%), monounsaturated fatty acids (more than 25% principally oleic acid) and low values of polyunsaturated fatty acids (less than 4% mainly linoleic acid). Slight changes can be noticed in fatty acids profile of the five food purees due either to species and/or the used tissue of the fish. This is may be attributed that the major fat source in such purees was milk fat, butter and powder milk. Foods contained polyunsaturated fatty acid (PUFA) which in babies promote brain development, improves psychomotor performance and visual functions [28].

3.1.5. Amino Acids and Nutritional Value

As seen from **Table 4**, using both fish species and their tissues as an ingredient in preparing weaning food purees had slight effect in their amino acids profile. F3 and F4 weaning food purees containing sardine fish had relatively higher levels of sulfur containing amino acids, tyrosine, histidine and slight lower values of lysine, alanine and glycine than these including bolti one, F1 and F2. On the other side, F5 weaning food puree containing 1:1 w/w ratio of muscles of both bolti and sardine fish had an equilibrium level of essential and non-essential amino acids. Also, the five formulated weaning purees prepared in this study had higher essential amino acids than those reported in FAO provisional pattern,

Table 4. Amino acids composition (AA) and nutritional value of fish based weaning food puree.

Amino Acids(AA) (g/100g protein)	Fish based weaning food puree*					Provisional AA pattern**
	F1	F2	F3	F4	F5	
Isoleucine	5.84	5.65	5.23	5.05	5.31	}9
Leucine	7.73	7.55	8.04	8.11	8.01	
Lysine	9.76	9.68	8.01	8.21	8.90	4.2
Methionine	1.49	1.32	2.66	2.59	2.17	}2.2
Cystien	0.98	0.99	0.88	0.79	0.91	
Phenylalanine	3.78	3.85	3.75	3.89	3.81	}5.6
Tyrosine	2.74	3.06	3.91	3.97	2.72	
Threonine	4.11	4.21	4.46	4.52	4.24	2.8
Valine	5.55	5.91	5.64	5.68	5.52	4.2
Hisitidine	1.68	1.78	2.23	2.13	2.15	
Argnine	2.9	3.21	3.26	3.15	3.36	
Aspartic acid	10.10	10.06	9.89	9.92	10.24	
Glutamic acid	17.75	18.66	10.73	18.84	18.21	
Serine	4.56	4.27	4.55	5.62	5.61	
Proline	5.95	5.67	5.62	5.66	6.09	
Alanine	5.06	5.41	4.96	3.82	4.11	
Glycine	4.78	4.45	3.88	3.91	4.33	
IVPDT (%)	100	100	100	100	100	
C-PER	3.12	2.99	2.78	3.32	3.24	
C-BV	126.32	125.61	110.76	112.52	118.67	

*Bolti muscles (F1), bolti muscles with its bones (F2), sardine muscles (F3), sardine muscles with its bones (F4) and a mixture of 1:1 w/w of muscles of bolti and sardine (F5). **FAO recommended provisional amino acid pattern for preschool children.

Table 4. Generally including fish bones with their muscles in preparing weaning food purees did not much affect their amino acids profile.

Results of amino acids in Table 4 revealed that among the essential amino acids, lysine was found in the highest amount followed by leucine, isolusine, valine, threonine, arginine, histidine, and sulfur containing amino acids respectively in the five weaning food formulations. Meanwhile, glutamic acid was the major nonessential amino acids followed by aspartic acid, proline, alanine, serine, glycine and tyrosine respectively in the five prepared weaning food purees.

The IVPDI of the five prepared weaning food puree was found to be 100%, Table 4. This means good and easy protein digestibility. It is also an indication that fish bones were carefully softened and homogenized during cooking. Fish puree and through sterilization of weaning foods. Heating treatment caused protein denaturation. Such changes facilities susceptibility of the protein to enzyme attacked and becomes easily digestible.

[9] [29] explained that the infant digestive system cannot fully hydrolyze proteins during the first two years of life and the use of predigested foods, could be good for these age groups.

Differences in the calculated values of C-PER and C-BV, Table 4, revealed the variations in amino acids content among the five prepared weaning food purees. Slight differences in C-PER (2.78 - 3.32) were observed among the five weaning food formulations. In contrast, C-BV value was higher in F1 and F2 weaning purees containing bolti fish tissues rich in lysine amino acid than other formulations including sardine fish. Generally results in Table 4 confirmed the good nutritional value of the five prepared weaning food purees in this study.

3.2. Physicochemical and Sensorial Properties

1) Colour: Data in Table 5 showed that both redness and yellowness of the weaning food purees colour did not significantly change due to using fish species and tissue yellowness represented the main fraction of the actual colour of the five weaning food purees. Meanwhile the redness fraction considered the complementary colour of these purees. Therefore the visual colour of such products can be described as yellowish. Lightness of this colour was significantly differed, Table 5, among these products. It was less in products including bones and with high fat content, F2, F3 and F4, Table 2.

2) Texture: Except hardness, the other texture characteristics; cohesiveness, springiness, gumminess, and chewiness of five weaning food purees did not significantly changed, Table 5. Meanwhile, F2 formulation containing highest value of Ca and P, relatively low fat content and moisture value, Table 2, was higher in hardness than other formulations. It is followed by F4, F1, F5 and F3 formulations respectively. This means that hardness was less in purees high in fat and fish bone free. Also, heat treatment may affect hardness particularly in products containing fish bones. Collagen in fish bones and skins can transform into gelatin by heating. Solidification of gelatin after cooling to hard gel may be

Table 5. Colour, texture and sensory characteristics of fish based weaning food puree.

Charater	Fish based weaning food puree*				
	F1	**F2**	**F3**	**F4**	**F5**
1-Colour					
Lightness (L*)	54 ± 1.20^{a}	50.78 ± 1.05^{b}	52.00 ± 0.14^{b}	53.12 ± 1.42^{ab}	52.81 ± 1.06^{ab}
Redness (a*)	10 ± 0.81^{a}	12.62 ± 0.41^{a}	10.30 ± 0.74^{a}	10.91 ± 0.42^{a}	10.21 ± 0.42^{a}
Yelloness (b*)	26 ± 0.21^{a}	25.88 ± 0.32^{a}	24.71 ± 1.23^{a}	25.23 ± 1.32^{a}	26.02 ± 1.2^{a}
2-Texture					
Hardness (g)	118 ± 1.43^{a}	67 ± 0.62^{c}	61 ± 0.51^{d}	110 ± 1.00^{b}	63.8 ± 2.01^{d}
Cohesiveness	0.5 ± 0.01	0.51 ± 0.01	0.76 ± 0.01	0.49 ± 0.01	0.48 ± 0.01
Springiness (mm)	4.77 ± 0.03	3.93 ± 0.02	3.29 ± 0.04	4.73 ± 0.03	5.84 ± 0.41
Gumminess (g)	24 ± 1.00	25 ± 0.12	24 ± 0.10	26 ± 0.21	24 ± 0.32
Chewiness (mg)	1.14 ± 0.10	1 ± 0.10	0.8 ± 0.01	1.1 ± 0.01	0.98 ± 0.01
Sensory Properties					
Appearance	Good	Good	Good	Good	Good
Feel in mouth	Good	Good	Good	Good	Good
Flavour	Good	Good	Good	Good	Good
Easy of using	Good	Good	Good	Good	Good

responsible of the relative increase of hardness in such products. Most weaning food is semisolid with soft texture. The flow characteristics of infant foods must be thick enough to stay in the spoon, but not too thick as to make swallowing difficult [6] [7].

3) Sensorial properties: Results in **Table 5** indicated that the children mothers accepted the appearance, flavor and mouth feel of the five weaning food purees prepared in this study with a good degree of acceptability. Also, they described the method of using such products as convenience and easy. They mentioned that all products were homogenous, with smooth texture, free from clumps and an off-flavor.

4. Conclusion

The above data confirmed the successful use of under-utilized small sizes fish at 24% as an ingredient in preparing an edible good acceptable sterilizing weaning food purees rich in protein, fat, minerals especially Ca and P in addition to high nutritive value.

Acknowledgements

The authors are thankful to Prof. Dr. Yehia Gamal EL-Din Moharram, Prof. of Food Science and Technology, Faculty of Agric., El-Shatby, Alexandria University for his support and valuable advice during carrying out the work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Morgan, J.B. and Dickerson, J.W.T. (2003) Nutrition in Early Life. *British Journal of Nutrition*, **90**, 374.

[2] WHO (World Health Organization) and UNICEF (United Nations Children's Fund) (1998) Complementary Feeding of Young Children in Developing Countries: A Review of Current Scientific Knowledge. WHO/NUT/98.1, World Health Organization, Geneva.

[3] WHO (World Health Organization) (2000) Child and Adolescent Health and Development: Nutrition and Infant Feeding. World Health Organization, Geneva.

[4] Bansal, S. (2008) Food and Nutrition. A.I.T.B.S. Publishers, India.

[5] Cooke, L. and Fildes, A. (2011) The Impact of Flavour Exposure in Utero and during Mikl Feeding on Food Acceptance at Weaning and Beyond. *Appetite*, **57**, 808-811. https://doi.org/10.1016/j.appet.2011.05.317

[6] Alvarez, M.D. and Canet, W. (2013) Time-Independent and Time-Dependent Rheological Characterization of Vegetable-Based Infant Purees. *Journal of Food Engineering*, **114**, 449-464. https://doi.org/10.1016/j.jfoodeng.2012.08.034

[7] Sharma, M., Kristo, E., Corredig, M. and Duizer, L. (2017) Effect of Hydrocolloid Type on Texture of Pureed Carrots: Rheological and Sensory Measures. *Food Hydrocolloids*, **63**, 478-487. https://doi.org/10.1016/j.foodhyd.2016.09.040

[8] Hay, W.W. (2017) Optimizing Nutrition of the Preterm Infant. *Chinese Journal of Contemporary Pediatrics*, **19**, 1-21.

[9] Dolores, J., Marcelo, M., Adriana, G., Manuel, L. and Norma, S. (2020) Baby Purees Elaborated with Andean Crops. Influence of Germination and Oilsin Physico-Chemical and Sensory Characteristics. *LWT-Food Science and Technology*, **124**, Article ID: 108901. https://doi.org/10.1016/j.lwt.2019.108901

[10] Isabel, M., Marina S., Gaspar, R. and Marina, J.P. (1998) Content and *in Vitro* Availability of Fe, Zn, Mg, Ca and P in Homogenized Fish Based Weaning Foods after Bone Addition. *Food Chemistry*, **63**, 299-305. https://doi.org/10.1016/S0308-8146(98)00050-8

[11] Santipanichwing, R. and Suphantharika, M. (2007) Carotenoids as Colorants in Reduced-Fat Mayonnaise Containing Spent Brewer's Yeast β-Glucan as a Fat Replacer. *Food Hydrocolloids*, **21**, 565-574. https://doi.org/10.1016/j.foodhyd.2006.07.003

[12] Yuan, S. and Chang, S.K.C. (2007) Texture Profile of Tofu as Affected by Instron Parameters, Sample Preparation and Correlation of Instron Hardness and Springiness with Sensory Scores. *Journal of Food Science*, **72**, S136-S145. https://doi.org/10.1111/j.1750-3841.2006.00263.x

[13] AOAC (Association of Official Analytical Chemists) (2000) Official Methods of Analysis. 17th Edition, Association of Official Analytical Chemists, Gaithersburgh.

[14] AOAC (Association of Official Analytical Chemists) (2012) Official Methods of Analysis. 19th Edition, Association of Official Analytical Chemists, Gaithersburgh, No. 994. Chapter 4, 9-13.

[15] Ali, G.H. (1999) Utilization of Guava and Mandarin Seeds as Potential Source of Oil and Protein. MSC. Thesis, Faculty of Agriculture, Alexandria University, Alexandria.

[16] Khattab, R.Y.I. (2004) Chemical and Technological Studies on Flaxseed to Improve Its Sensorial and Nutritional Properties in Food. PHD Thesis, Faculty of Agriculture. Alexandria University, Alexandria.

[17] Stansby, M.E. (1962) Proximate Composition of Fish. In: Eirik, H. and Rudolfkreuser, Eds., *Fish in Nutrition*, Fishing News (Books) Ltd., London, 55-60.

[18] Taga, M.S, Miller, E.E. and Pratt, D.E. (1984) Chia Seeds as a Source of Natural Lipid Antioxidants. *Journal of American Oil Chemists Society*, **61**, 928-931. https://doi.org/10.1007/BF02542169

[19] Zaitseviv, V., Kizevetter, I., Lagunov, L., Makarova, T., Minder, L. and Podsevalov, V. (1969) Fish Curing and Processing. MIR Publishers, Moscow.

[20] Nicklaus, S. (2011) Children's Acceptance of New Foods at Weaning. Role of Practices of Weaning and of Food Sensory Properties. *Appetite*, **57**, 812-815. https://doi.org/10.1016/j.appet.2011.05.321

[21] Martína, M., Gómez, S. Arboleyab., M., Gueimonde, C. and González, S. (2019) Nutritional Composition of Processed Baby Foods Targeted at Infants from 0-12 Months. *Journal of Food Composition and Analysis*, **79**, 55-62. https://doi.org/10.1016/j.jfca.2019.03.009

[22] Garcia, A.L., McLean, K. and Wright, C.M. (2016) Types of Fruits and Vegetables Used in Commercial Baby Foods and Their Contribution to Sugar Content. *Maternal & Child Nutrition*, **12**, 838-847. https://doi.org/10.1111/mcn.12208

[23] Navarro, M.P. (1991) Valor Nutritive Delpescado. I. Pescado Fresco. *Revista de Agroquimica y Tecnologia de Alimentos*, **31**, 330-342.

[24] Cruz, M.L.A. and Tsang, R.C. (1992) Introduction to Infant Mineral Metabolism. In: Tsang, R.C. and Mimorin, F., Eds., *Calcium Nutriture for Mother and Children*, Raven Press, New York, 1-11.

[25] Aranda, P. and Llpois, J. (1993) Minerals. In: Llopis, J., Ed., *Nutrición y Dietética*: *Aspectos Sanitarios*, Consejo General de Colegios Oficiales de Farmaceúticos, Madrid, 179-240.

[26] FAO (Food and Agriculture Organization of the United Nations)/OMS (Organisation mondiale de la santé) (2006) Programme mixte FAO/OMS sur les normes alimentaires. Rapport des vingt-septième sessions du comité du codex sur la nutrition et les aliments diététiques ou de régime. ALINOM 06/29/26, 105 p., Food and Agriculture Organization of the United Nations, Rome; World Health Organization, Geneva.

[27] Nkeudem, G.A., Sumbele, I., Anchang-Kimbi, J.N., Samuel, M. and Kaptso, K.G. (2018) Nutritional Evaluation of Commonly Used Local Weaning Food Processed and Sold in the Mount Cameroon Region. *International Journal of Food Science and Nutrition Engineering*, **8**, 131-141.

[28] Diallo, M., Cissé, M., Dessor, F., Soulimani, R., Sock, O. and Desobry, S. (2013) Formulation of Infant Food Based on Local Cereals: Stability and Effects on Cognitive Development. *Journal of Nutrition & Food Sciences*, **3**, Article No. 211. https://doi.org/10.4172/2155-9600.1000211

[29] Gan, J., Bornhorst, G.M., Henrick, B.M. and German, J.B. (2018) Protein Digestion of Baby Foods: Study Approaches and Implications for Infant Health. *Molecular Nutrition & Food Research*, **62**, Article No. 1700231. https://doi.org/10.1002/mnfr.201700231