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Evaluation of Some Physicochemical Parameters of Commercial Baby Foods Products

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Abstract

The nutritive value of ten baby foods commonly used in Libya was evaluated chemically including pesticide residues and bacterial contamination. The protein and fat content differed significantly in the examined baby foods and ranged from 7.5 % to 13.4% and 7.9% to 13.2%, respectively. The actual protein and fat contents were lower than those that declared on the manufacturer's labels for all the baby foods studied here. The crude fiber content was in the range of 5.68-15.73 % for the fruit pulps and from 13.85-20.45 % for the dried fruits and vegetables; all samples in this study were low in ascorbic acid and also in total dissolved solids content and could not meet Libyan standard specifications. However, the data presented show that in general all of the pesticide residues monitored are in concentrations below the limit of detection (LOD). All products analysed during the study did not contain any bacterial contamination.

Keywords:* *Baby food; Misurata- Libya; Nutritional evaluation; Pesticide

Introduction

There is much evidence that the quality and composition of commercial baby food may contribute to the present and future health benefits of young children. Since infants between 6 months and 3 years of age are rather limited in their food choices, commercial fruit baby foods serve as a very important source of energy, basic nutrients, fiber, vitamins and minerals and establish their future taste and eating patterns. Whereas the food safety of baby food from the view of chemical pollution and microbiological contamination is a priority for both producers and state authorities, the composition and nutritive quality of these products are often underestimated [1].

The nutritive value of a baby food depends significantly on the composition, the raw materials used in its production and the proportional content of its component fruits or vegetables. Apart from being a source of energy, fruit baby foods are perceived to be major sources of fiber, ascorbic acid, polyphenols and other antioxidants in diets based on the fruit (vegetable) content and composition [2,3].

The other important factors affecting the nutritive value of baby foods are the conditions used in their processing and associated parameters which could cause the reduction of nutrients in products, such as oxidation, non-enzymatic browning

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and the presence of contaminants. These factors are usually affected by heating, therefore the thermal damage that arises during the blanching, boiling, sterilization in the preparation and improper storage conditions prior to retail, are critical for the nutritive value of baby food.

Prolonged breast feeding up to 2 years has been widely practiced in the Kingdom. However, due to rapid socioeconomic changes and urbanization, breast feeding rates have declined and bottle feeding trends at an early age have increased.

The protein quality of milk-based and milk cereal foods for infants and children, consumed in different countries, have been reported to be lower than that for whole milk. Adequate information on the nutritional quality of the commercial baby food consumed in Libya is not available currently [4-7].

Reduction of the risk to children from pesticide contamination in agricultural products requires an understanding of the pathways by which exposure occurs. Dietary ingestion is one of the main pathways by which children are exposed to pesticides. Children eat more food relative to their body mass than adults and their dietary requirements are different from those of adults [8]. Baby foods should be free of pesticide residues, according to the extremely low maximum residue limits (MRLs) established by the European Community in 2006 [9]. Thus, the monitoring of pesticide residues in such high risk matrices should be accurate and reliable [10]. Pesticides protect crops from pests and are economically beneficial. However, these substances can transfer to the food and affect consumer health, especially in the food consumed by infants and children, who are a vulnerable risk group. Moreover, pesticide residues represent food safety issues of high concern and on this account various surveillance/compliance programs exist in all developed countries as an integral part of measures aimed at consumer protection. As shown in the available reports [11-20]. Pesticides have hitherto been determined in baby food by the use of a wide range of techniques such as HPLCMS/ MS, GC-MS, GC-ECD, GC-MS-MS [21-24]. The present paper deals with the nutritional of some common commercial baby food sold in Libya by chemical analysis including contamination by pesticide residues.

Material and Methods

Selection of baby foods

Two different types of baby foods (1) Cereal blends and (2) Pulp of fruits were selected on the basis of their popularity and availability in Misurata City, and were purchased from the commercial market. A pool of samples was prepared by combining a portion of each brand. An aliquot of this pooled sample was divided into three portions and each was analyzed separately. TABLE 1 shows the components of the baby food as indicated on the packaging.

TABLE 1. **Baby food packaging and their characteristics.**

No sample	**Sample characteristics**	**Package type**
1	Pulp of fruits and vegetables mixed	Glass bottle
2	Fruit paste of carrot, apple and guava	Glass bottle
3	Pulp carrot and apple	Glass bottle

4	Pulp banana and apple	Glass bottle
5	Pulp, mixed fruit	Glass bottle
6	Rice based with vegetables	Paper box
7	Rice based with apple	Paper box
8	Cereal with milk based, wheat, honey and rice	Paper box
9	Cereal with rice and honey	Paper box
10	Rice based with fruits	Paper box

Chemical analysis

The chemical composition of baby food was determined according to standard methods [25]. Crude protein was estimated from the nitrogen content by Kjeldahl methods. Fat content was determined by ether extraction using a Soxhlet apparatus. Available carbohydrates were calculated by difference, phosphorus by spectrophotometry, lactose, titratable acidity and solids not fat (SNF) contents by Milk-O-Scan as described by Marques and Belo [26]. All glassware was washed thoroughly before use with distilled water, soaked in nitric acid (30%), then rinsed in redistilled water , air-dried and was then stored and kept in a clean place to avoid contamination.

Pesticide residues analysis

1. 15 g of homogenized baby food was added to the 50 ml DisQuE extraction tube. 15 ml of 1%acetic acid in acetonitrile.
2. The mixture was shaken vigorously for 1 minute and centrifuged to 1500 rcf for 1 minute.
3. 1ml of the acetonitrile extract was transferred into a 2 ml 50 ml DisQuE cleanup tube.
4. This was shaken for 30 seconds and centrifuged to 1500 rcf for 1 minute.
5. 100 µl of this final extract was transferred into an auto-sampler vial and diluted with 900 µl water, mix, and then injected into the instrument described below.

Extracted baby food samples were analyzed using a Waters Ultra Performance Liquid Chromatography (UPLC) system combined with the fast MS acquisition rates of the Xevo™ TQ Mass Spectrometer (TABLE 2).

TABLE 2. **LC and MS conditions.**

LC Conditions		**MS Condition**	
LC system	ACQUITY UPLC® System	**MS system**	Xevo TQ MS/MS

Colum	ACQUITY UPLC BEH C_{18} 2.1 ×50 mm, 1.7µm	**Ionization mode**	ESI+
Colum temp.	40ºC	**Capillary voltage**	0.6 kV
Sample Temp.	4ºC	**Desovation gas**	Nitrogen, 1000 lHr, 400ºC
Flow rate	0.7 ml/min	**Cone gas**	Nitrogen, 25 l/Hr
Mobile phase A	Water + 0.1% formic acid	**Source temp.**	120ºC
Mobile phase B	Methanol + 0.1% formic acid	**Acquisition**	Multiple reaction Monitoring (MRM)
Gradient	0.00 min 99% A 5.00 min 1% A 6.00 min 1% A 6.10 min 99% A 8 min 99% A	**Collision gas**	Argon at 3.5×10^{-3}mBar
Weak Needle Wash	Water + 0.1 % formic acid	-	-
Strong Needle Wash	Methanol + 0.1 % formic acid	-	-
Total run time	8 min	-	-
Injection time	50 µl, full loop injection	-	-

Data analysis

All measurements were carried out in triplicate and presented with a mean ± standard deviation (SD). Significant differences among mean values, where applicable, were determined by one-way analysis of variance (ANOVA). A p value <0.05 was considered statistically significant. For all statistical calculations a standard statistical package of software SPSS 20 was used [27].

Results and Discussion

Moisture content

The Moisture content in the selection of baby foods analyzed (Mean ± S.D., N=15 in triplicate for each sample) is given in TABLE 3.

TABLE 3. **Moisture, Ash and Total Dissolved Solids Content (%) in different kinds of baby foods.**

Samples	Moisture Content (%)	Ash Content (%)	Total Dissolved Solids Content (%)
1	75.61 ± 0.167	0.372 ± 0.168	21.8 ± 1.316
2	75.591 ± 0.393	0.122 ± 0.482	18.1 ± 1.853
3	70.877 ± 0.215	0.289 ± 0.571	20.6 ± 0.723
4	73.661 ± 0.227	0.344 ± 0.398	19.4 ± 2.341
5	74.765 ± 0.296	0.553 ± 0.741	21.348 ± 1..983
6	4.617 ± 0.631	1.20 ± 0.635	-
7	2.985 ± 0.496	1.70 ± 0.519	-
8	4.428 ± 0.853	1.8 ± 0.758	-
9	4.348 ± 0.938	2.7 ± 0.286	-
10	3.514 ± 0.689	1.9 ± 0.395	-

The results of this study revealed that the moisture content was in the range of 70.877-75.61% in the Pulp of fruits and from 2.985 -4.617% for dried baby foods. A comparison of the moisture content in baby foods with the Libyan official standards indicated that rice based with vegetables (4.617 ± 0.631), cereal with a milk base, wheat, honey and rice (4.428 ± 0.853) and cereal with rice and honey (4.348 ± 0.938) all had higher contents than the Libyan standard (4%wt/wt%). The moisture content is used as a quality factor for prepared cereals which should have a moisture content lying in the range 2-8% [28].

Ash content

The ash content in the different kinds of baby foods (Mean ± S.D., N=15 in triplicate for each sample) is given in TABLE 3. The results of this study revealed that the ash content was in the range of 0.122 - 0.553% for the pulp of fruits and from 1.20-2.7% for the dried fruits and vegetables. TABLE 1 shows that in the sampled pulps of fruits (1,3,4,5), the ash content was rather higher than that stated in the Libyan standard specifications for these foods except sample 2, where the Libyan standard specification recommended that the ash content should not exceed 0.25% by dry weight, while for the samples (6-8,10), the percentage of ash was significantly higher than Libyan standard specification. Our study results were lower than those reported by Khan et al., and Raza et al., [29,30].

Total dissolved solids content

The present study revealed that total dissolved solids content of different kind of baby foods ranged from 18.1% to 21.8% which therefore could not meet Libyan standard specifications (25%).

Protein content

During infancy, a large amount of protein is required because it is essential for normal growth, body development and tissue repair. The present study revealed that protein contents differed significantly among most of the examined baby foods and ranged from 7.5% to 13.4% as shown in TABLE 4. Moreover, for all baby foods studied here the actual protein contents were lower than that declared on the manufacturer's labels.

Another study reported an average protein content of 11.63% in formulas collected from developing countries which compared with a value of 12.14% in formulas collected from developed countries [31]. Protein contents of infant formulas set in the Codex Alimentations range between 1.8 and 3.0 g/100 kcal (about 12.0 to 20%) [32]. Kan et al., reported that the protein content of milk-based formula and cereal – milk blends varied between 13.3 and 26.0 % and between 11.1 and 13.2%, respectively [29]. In the present study, the protein quality of all the baby food tested fulfilled the FAO/ WHO requirements, except for samples (1-3).

TABLE 4**. Protein, fats, ascorbic acid, fibres and acidity content in different kinds of baby foods.**

Samples	**Protein (%)**	**Fats (%)**	**Ascorbic Acid (mg/100g)**	**Crude Fiber (g/100g)**	**Acidity (%)**
1	7.5 ± 0.412	4.3 ± 0.212	4.60 ± 0.131	0.252 ± 5.68	0.6 ± 0.173
2	8.6 ± 0.371	5.3 ± 0.615	4.70 ± 0.517	0.964 ± 8.34	0.3 ± 0.284
3	11.4 ± 0.482	8.7 ± 0.176	8.60 ± 0.461	0.692 ± 6.92	0.4 ± 0.217
4	12.1 ± 0.253	13.2 ± 0.953	6.30 ± 0.731	0.391 ± 10.49	0.5 ± 0.215
5	13.4 ± 0.815	2.6 ± 0.276	4.10 ± 0.624	0.756 ± 15.73	0.6 ± 0.371
6	12.3 ± 0.426	1.93 ± 0.612	3.60 ± 0.725	0.274 ± 18.75	0.16 ± 0.153
7	12.5 ± 0.715	1.97 ± 0.362	6.80 ± 0.826	0.212 ± 13.85	0.18 ± 0.029
8	12.1 ± 0.451	1.80 ± 0.274	2.11 ± 0.742	0.167 ± 20.45	0.20 ± 0.1.21
9	12.9 ± 0.215	1.79 ± 0.153	6.30 ± 0.287	0.235 ± 17.74	0.18 ± 0.1.23
10	12.3 ± 0.145	1.85 ± 0.128	7.10 ± 0.195	18.98 ± 0.123	0.21 ± 0.149

Fat content

The present study showed that the fat content of different kinds of baby foods ranged from 1.79% to 13.2%. The actual fat contents were lower than that declared on the manufacturers label in all formulas. A wider range was reported by another study (3.86 and 29.83%) [31]. Fat contents of infant formulas set in the Codex Alimentations range between 29.3 to 40.0% [32]. The infant formulas should supply fat from 22 to 40% [33]. All samples in this study had low fat content and could not meet the Codex requirements.

The low fat content of canned baby foods and dried baby foods during storage at room temperature, may be due to storage conditions or oxidation of the fatty substances contained in the mixture, the exposure to light and oxygen or the presence of metal contamination in the mixtures which helped to oxidize fat [34,35].

Crude fiber

The crude fiber content in the different kinds of baby foods is given in TABLE 4. The results of this study revealed that the crude fiber content was in the range of 5.68-15.73% for the fruit pulps and from 13.85-20.45% for dried fruits and vegetables. From TABLE 4, we note that the fiber content varied in most samples. In general, the fiber content in the dry samples was higher than in the wet baby foods. This variation in fiber content may be due to the storage temperature of the product or of the differential production processes.

Ascorbic acid

The present study showed that the ascorbic acid content of different kinds of baby foods ranged from 2.11 to 8.6 mg/100g. All samples in this study had low ascorbic acid content and could not meet Libyan standard specifications which recommended that the content of ascorbic acid should not be less than 20 mg / 100 g. Čížková reported that the ascorbic acid content of baby food varied between 18.6 to 55.5 mg/100g which is higher than that found in our study [36]. The decrease in the content of ascorbic acid determined here may be due to its significant oxidative breakdown during storage. Markedly higher reductions in ascorbic acid were found with increased storage time in all samples; after two months of storage we found that the average percent loss of ascorbic acid in our specimens was 55% [37].

Acidity

The percentage of acidity based on citric acid ranges from 0.18 to 0.6%, meaning that the acidity content in most samples generally falls within the limits recommended by the Libyan standard specifications where it is recommended that the content of acidity should not be higher than 0.4%.

Pesticide Residues

The data presented show in general that all of the pesticide residues monitored are found to occur in concentrations below LOD.

TABLE 5. **List of pesticides used in all samples.**

No	Pesticide	Result (ppm)	LQ (ppm)	MRL-EU (ppm)
1	**Abamectine**	<LQ	0.01	0.01
2	**Acetamipride**	<LQ	0.01	0.01
3	**Acrinatrine**	<LQ	0.01	0.01
4	**Aldrine**	<LQ	0.01	0.010D
5	**Azoxystrobine**	<LQ	0.01	0.01
6	**Bromuconazole**	<LQ	0.01	0.01
7	**Bentazone**	<LQ	0.01	0.01
8	**Boscalide**	<LQ	0.01	0.01
9	**Carbofuran**	<LQ	0.01	0.01
10	**Carbaryl**	<LQ	0.01	0.01
11	**Cloquintocet-mexyl**	<LQ	0.01	0.01
12	**Cymoxanil**	<LQ	0.01	0.01
13	**Chlorantraniprole**	<LQ	0.01	0.01

14	**Clodinafop-propargyl**	<LQ	0.01	0.01
15	**Chlorpyrifos ethyl**	<LQ	0.01	0.01
16	**Chromafenozoide**	<LQ	0.01	0.01
17	**Cyproconazole**	<LQ	0.01	0.01
18	**Ccarbendazime**	<LQ	0.01	0.01
19	**Difenoconazole**	<LQ	0.01	0.01
20	**Deltamethrine**	<LQ	0.01	0.01
21	**Dimethothoate**	<LQ	0.001	0.003
22	**Dimexostrobine**	<LQ	0.01	0.01
23	**Ethofumezate**	<LQ	0.01	0.01
24	**Epoxiconazole**	<LQ	0.01	0.01
25	**Fenamidone**	<LQ	0.01	0.01
26	**Fenexaprop-p-ethyl**	<LQ	0.01	0.01
27	**Flubendiamide**	<LQ	0.01	0.01
28	**Flufenoxuron**	<LQ	0.01	0.01
29	**Fenproproximate**	<LQ	0.01	0.01
30	**Fenpropimorphe**	<LQ	0.01	0.01
31	**Fenamiphos**	<LQ	0.01	0.01
32	**Fluodioxinil**	<LQ	0.01	0.01
33	**Fenhexamide**	<LQ	0.01	0.01
34	**Fenoxycarbe**	<LQ	0.01	0.01
35	**Hexythiazox**	<LQ	0.01	0.01
36	**Imidaclopride**	<LQ	0.01	0.01
37	**Iindoxacarbe**	<LQ	0.01	0.01
38	**Lufenuron**	<LQ	0.01	0.01
39	**Lamda-cyhalothrine**	<LQ	0.01	0.01
40	**Myclobutanil**	<LQ	0.01	0.01
41	**Metrhomyl**	<LQ	0.01	0.01
42	**Metribuzine**	<LQ	0.01	0.01
43	**Methiocarbe**	<LQ	0.01	0.01
44	**Methabenthiazuron**	<LQ	0.01	0.01
45	**Methidathion**	<LQ	0.01	0.01
46	**Malathion**	<LQ	0.01	0.01
47	**Metalaxyl**	<LQ	0.01	0.01

48	**Propamocarbe-HCl**	<LQ	0.01	0.01
49	**Penconazole**	<LQ	0.01	0.01
50	**Propagite**	<LQ	0.01	0.01
51	**Pyraloxystrobine**	<LQ	0.01	0.01
52	**Pencycuron**	<LQ	0.01	0.01
53	**Pinoxadene**	<LQ	0.01	0.01
54	**Pyrimethanil**	<LQ	0.01	0.01
55	**Tefluthrine**	<LQ	0.01	0.01
56	**Tebuconazole**	<LQ	0.01	0.01
57	**Thimethoxame**	<LQ	0.01	0.01
58	**Triticonazole**	<LQ	0.01	0.01
59	**Thiabendazole**	<LQ	0.01	0.01
60	**Trifloxystrobine**	<LQ	0.01	0.01
61	**Thiaclopride**	<LQ	0.01	0.01
62	**Tetradifon**	<LQ	0.01	0.01
63	**Spiromesifene**	<LQ	0.01	0.01
64	**Spinosad (A+D)**	<LQ	0.01	0.01
65	**Spirodiclofene**	<LQ	0.01	0.01

*LQ= Limit of Quantification

*ppm= mg/kg

*MRL-EU= Maximum residue levels-European Union.

Bacterial Contamination

All products analyzed during the study did not contain any bacterial contamination, contrary to what was observed by Iversen et al. 2004 who analyzed 82 powdered infant formulas and found a contamination by Enterobactersakazakii, Enterobacter cloacae, Klebsiella pneumonia and Citrobacterfreundii [38]. In recent years manufacturers have implemented strategies to control microbial contamination and this is attributed to the absence of these pathogens in this study.

TABLE 5. **Total number of microbes (cfu / gm) in mixtures of baby food.**

Samples	**Enterobacteriacca**	**Shegella**	**Mould**	**Yeast**	**Salmonella**	**Staph**	**E-Coli**	**Coli form**
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-

8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-

Where: (-) not detected.

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