

Nutritional evaluation of some commercial baby foods consumed in Saudi Arabia

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The nutritive value of six baby foods based on milk (Nido, Wadi Fatima and Gain) and milk-cereal blends (Cerelac with wheat, Cerelac with rice and Milupa 2) commonly used in the Kingdom of Saudi Arabia was evaluated chemically including fatty acids analysis and biologically in growing rats. The milk based products vs milk-cereal blends provided (per 100 kcal) protein (3.8–5.0 g vs 3.7–3.8 g), fat (5.2–5.7 g vs 2.0–4.8 g), available carbohydrates (7.3–9.5 g vs 10.5–16.6 g), Ca (159–189 mg vs 101–145 mg), Mg (15–18 mg vs 14–20 mg), Na (32–39 mg vs 42–51 mg), K (160–180 mg vs 122–144 mg), Fe (1.4–1.8 mg vs 1.5–1.9 mg), Cu (0.04–0.09 mg vs 0.09–0.1 mg), Zn (0.8–1.2 mg vs 0.8–1.1 mg), and linoleic acid (208–1343 mg vs 518–639 mg). Metabolizable energy (ME) values in milk based products (487–495 kcal/100 g) were higher than milk-cereal blends (404–473 kcal/100 g). The true protein digestibility (TD) varied from (93–95%) in milk based foods to (94–95%) in milk-cereal blends. The net protein utilization (NPU) ranged between (0.74–0.78) in milk based products and (0.68–0.74) in milk-cereal blends. The net dietary protein calorie percent (NDP cal%) was higher in milk based foods (11.7–15.0%) than milk-cereal blends (10.2–11.1%). An imbalance of calories and nutrients in some baby foods was noticed. However, the protein quality was satisfactory and could meet the protein requirements of infants and toddlers as indicated by NDP cal% values.

Introduction

Despite the fact that food availability increased by 90% during the last two decades in the Kingdom (Khan & Al-Kanhal, 1994), malnutrition is still present among the pre-school children (Almokhalalati, 1990). This may be attributed to decreased breast feeding, easy availability of commercial baby foods, poor hygiene and inappropriate weaning practices (Lawson, 1981).

Prolonged breast feeding up to 2 years has been widely practised in the Kingdom (Al-Othaimeen, 1990). However, due to rapid socio-

economic changes and urbanization, breast feeding rates have declined (Al-Frayh *et al.*, 1988) and bottle feeding trends at an early age have increased (Al-Sekait, 1988). Weaning foods are often started at the age of 4–11 months (Al-Othaimeen & Villanueva, 1988). On national level, 30% of the babies were consuming commercial baby foods (Sawaya *et al.*, 1985) and 95% of the bottle fed children received powdered milk only (Al-Othaimeen *et al.*, 1988).

According to the Fourth Development Plan (1985–90) the Kingdom has been importing

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400 000 tons of milk and its products every year (Ministry of Planning, 1985). The per capita availability of milk for consumption has been reported to be 297 g/day (Khan & Al-Kanhal, 1994). Thirty-six different infant formulas were available in the Kingdom (Al-Frayh, 1986) and nutrient contents of 55% of commercial baby foods did not match the FAO Codex standard (Lawson, 1981). The protein quality of milk-based and milk-cereal foods for infants and children, consumed in different countries has been reported to be lower than the whole milk (Sarwar *et al.*, 1989; Eggum, 1968; Abrahamsson & Hambræus, 1977; Khan & Eggum, 1979; Khan & Kissana, 1985). Adequate information on the nutritional quality of the commercial baby foods consumed in Saudi Arabia is not available. The present paper deals with the nutritional evaluation of some common commercial baby foods by chemical analysis, including fatty acids analysis and biologically in growing rats.

Materials and methods

Selection of baby foods

Two different types of baby foods (i) milk based products and (ii) milk-cereal blends, were selected on the basis of their popularity and availability in Riyadh city. The commercial milk based formulas viz. Nido (UK), Wadi Fatima (Holland) and Gain (USA) and milk-cereal blends namely Cerelac with wheat (Saudi Arabia), Cerelac with rice (Belgium) and

Milupa 2 (Germany) were purchased from the market. Table 1 shows the components of the baby foods as indicated on the packages.

Chemical analysis

The chemical composition of baby foods was determined according to standard methods (AOAC, 1990). Crude protein (NX6.25) was estimated from nitrogen content by Kjeldahl method. Fat content was determined by ether extraction using a Soxhlet apparatus. Available carbohydrates were calculated by difference. The energy value was determined by using Gallenkamp Ballistic Bomb Calorimeter and metabolizable energy (ME) was calculated according to Miller & Payne (1959). For the determination of minerals, 1–2 g samples were ashed in duplicate, dissolved in 20% HCl. Ca, Mg, Fe, Cu and Zn were determined with Perkin-Elmer (Model 1100-B) Atomic Absorption Spectrophotometer and Na and K were analysed with a Flame Photometer according to AOAC (1990). Fatty acids were analyzed by GLC on Shimadzu Gas Chromatograph with a flame ionization detector according to Thies (1971). All assays were performed in duplicate.

Biological evaluation

The experimental diets were prepared by mixing the food samples with corn starch to calculated protein levels of 10% and supplementing with 5% corn oil, 5% vitamin and mineral mixture. In order to measure the

Table 1. Components of the commercial baby foods

Products		Protein source											
		Milk			Cereals		Added sugar and starch				Added fat		
		Full cream	Partially skimmed	Skimmed	Wheat	Rice	Sucrose	Lactose	Honey	Starch	Corn meal	Butter	Vegetable oil
Name	Type												
Nido	Milk based	×											
Wadi Fatima		×											
Gain				×			×						×
Cerelac (wheat)	Milk-cereal		×		×		×				×		×
Cerelac (rice)			×			×	×						×
Milupa 2	blends		×			×		×	×	×		×	×

metabolic faecal nitrogen, a protein free diet consisting of corn oil 5%, glucose 15%, vitamin and mineral mixture 5% and corn starch 75% was included. A casein based diet served as control.

The experimental procedure has been described by Khan *et al.* (1992). Sixty-four weanling Albino rats, weighing between 50 and 60 g were grouped by randomized block design. The average weights of the groups differed by no more than ± 2 g. Each group consisted of four rats (male and female) housed in a screen mesh-bottomed cage. A sheet of filter paper was placed under each cage for the collection of faeces. The experimental diets were randomly assigned to these groups in such a way that each diet was fed *ad libitum* to two groups of rats for a period of 10 days. Fresh and clean water was provided all the time to each group. Gains in body weight were recorded daily. The record of feed intake was also maintained.

At the end of the experiment the rats were killed with chloroform. Incisions were made into skull, thoracic and abdominal cavities and the carcasses of each group were dried to a constant weight at 105°C. Dried carcasses were weighed and ground in an electric grinder. The nitrogen content of diets, faeces and carcasses of each group was determined by Kjeldahl method. The true protein digestibility (TD),

biological value (BV) and net protein utilization (NPU) were estimated according to the method of Miller & Bender (1955). Net dietary protein calorie percent (NDP cal%) was calculated according to Miller & Payne (1961). The data were subjected to statistical analysis by applying Tukey's Paired Comparison Procedure (Daniel, 1987).

Results and discussion

Chemical composition

The chemical composition (g/100 kcal and g/100 g) of different types of baby foods is given in Table 2. The protein content (g/100 kcal) in milk based products ranged from 3.8 g in Gain to 5.0 g in Nido and Wadi Fatima and was higher than human milk (1.5 g/100 kcal). According to FAO/WHO Codex Alimentarius Commission Standards for infant formulas, the protein content should range from 1.8–4.0 g/100 kcal (FAO/WHO, 1989). In the present study the protein content (3.8 g/100 kcal) in Gain was closer to the upper limit of the standard, but in both Nido and Wadi Fatima, due to their unmodified composition, the protein levels (5.0 g/100 kcal) were higher than the upper limit (4.0 g/100 kcal) of the standard. The protein content of all milk based formulas were similar to milk formulas

Table 2. Chemical composition (dry basis) of commercial baby foods

Products		g/100 kcal					Calories (kcal/100 g)	
Name	Type	Protein (N × 6.25)	Fat	Available carbohydrate	Crude fibre	Ash	Total	Metabolisable
Nido	Milk based	5.0 (26.5)	5.5 (28.5)	7.5 (39.2)	–	1.1 (5.8)	520	494
Wadi Fatima		5.0 (25.8)	5.7 (29.5)	7.3 (38.0)	–	1.3 (6.7)	521	495
Gain		3.8 (19.6)	5.2 (26.5)	9.5 (48.9)	–	1.0 (5.0)	513	487
Cerelac (wheat)	Milk–cereal blends	3.8 (16.3)	2.0 (8.5)	16.6 (70.8)	0.4 (1.5)	0.5 (2.3)	425	404
Cerelac (rice)		3.8 (16.2)	2.0 (8.7)	16.6 (71.2)	0.2 (1.0)	0.7 (2.9)	428	407
Milupa 2		3.7 (18.5)	4.8 (24.0)	10.5 (52.1)	0.2 (0.9)	0.9 (4.5)	498	473

Figures in parentheses indicate values g/100 g.

(3.2–6.0 g/100 kcal) used in Pakistan (Khan & Kissana, 1985), but were higher than those consumed in Canada (2.20–2.95 g/100 kcal), in Sweden (2.20–2.62 g/100 kcal) and in Western European countries (2.24–2.83 g/100 kcal) as reported by Sarwar *et al.* (1989), Abrahamsson & Hambraeus (1977) and Pompei *et al.* (1987) respectively.

The protein content in milk–cereal blends varied between 3.7 g/100 kcal in Milupa 2 and 3.8 g/100 kcal in Cerelac with wheat and Cerelac with rice (Table 2). The protein content in these blends agree well with the protein content (3.0–5.5 g/100 kcal) of follow up formula/weaning foods as recommended by Codex Commission (FAO/WHO, 1989).

Fat concentration was higher in milk based products (5.2–5.7 g/100 kcal) than milk–cereal blends (2.0–4.8 g/100 kcal). The infant formulas should supply fat from 3.3–6.0 g/100 kcal (FAO/WHO, 1989). All the milk based products (Nido, Wadi Fatima and Gain), in the present study, had adequate fat to meet the Codex requirements. However, among the milk–cereal blends, both Cerelac with wheat and Cerelac with rice had low fat content (2.0 g/100 kcal) and could not meet the Codex requirements (3.0–6.0 g/100 kcal) for weaning foods. The available carbohydrates in milk based products were comparatively lower (7.3–9.5 g/100 kcal) than milk–cereal blends (10.5–16.6 g/100 kcal). Similar values in commercial baby food consumed in Pakistan have been reported by Khan & Kissana (1985). The crude fibre content ranged from 0.2–0.4 g/100 kcal in milk–cereal blends (Table 2). The ash content was highest (1.3 g/100 kcal) in Wadi Fatima and was lowest (0.5 g/100 kcal)

in Cerelac with wheat. The ME values were highest (487–495 × kcal/100 g) in milk based products, whereas lowest values (404–473 kcal/100 g) were observed in milk–cereal blends. The chemical composition in the present study was found to be similar to nutrient contents of baby foods, claimed by the manufacturers.

Table 3 shows the fatty acid composition (% wt/wt) of commercial baby foods. Total saturated fatty acids were highest (54.0–71.1%) in milk based products and were lowest (36.3–51.5%) in milk–cereal blends. The oleic content varied from 20.0% g in Gain to 37.8% in Cerelac with wheat. The content of linoleic acid was highest (26.0% wt/wt) in Cerelac with rice, whereas lowest content (3.8% wt/wt) was found in Nido. The content of linolenic acid ranged from 0.2–0.6% wt/wt. The high content of saturated fatty acids in Wadi Fatima and Nido may be due to full cream milk or butter whereas high content of linoleic acid in Gain, Cerelac with wheat and Cerelac with rice may be due to vegetable oils used in these products. It was interesting to note that the presence of linoleic acid in Gain (25.5%), Cerelac with wheat (25.6%), Cerelac with rice (26.0%) and Milupa 2 (14.3%) were higher whereas in Nido (3.8%) and Wadi Fatima (4.5%) were lower than the linoleic acid content (10.8%) of human milk as reported by Koletzko *et al.* (1988). High level of saturated fatty acids in milk formulas are less absorbed and may inhibit calcium absorption (Chapell *et al.*, 1986). A comparison of linoleic acid contents (mg/100 kcal) in baby foods with FAO/WHO Codex standard (1989) indicated that Nido (208 mg), Wadi Fatima (254 mg) had lower whereas Gain (1343 mg), Cerelac with wheat (518 mg), Cerelac with rice (533 mg) and

Table 3. Fatty acid composition (% wt/wt) of commercial baby foods

Products		Saturated					Unsaturated		
		Lauric acid	Myristic acid	Palmitic acid	Stearic acid	Total	Oleic acid	Linoleic acid	Linolenic acid
Name	Type								
Nido	Milk based	2.8	14.2	35.3	11.0	63.3	32.3	3.8	0.6
Wadi Fatima		4.3	15.8	41.5	9.5	71.1	24.0	4.5	0.4
Gain		31.1	10.6	10.2	2.1	54.0	20.0	25.5	0.5
Cerelac (wheat)	Milk–cereal	–	5.8	23.9	6.6	36.3	37.8	25.6	0.3
Cerelac (rice)	blends	–	6.5	26.0	6.3	38.8	35.0	26.0	0.2
Milupa 2		3.4	3.4	40.6	4.1	51.5	33.7	14.3	0.5

Milupa 2 (689 mg) had higher contents than Codex standard (300 mg/100 kcal). According to American Academy of Pediatrics (AAP, 1985) the infant formula must provide at least 2.7% of energy as linoleic acid. In the present study linoleic acid contents as percent of the total calories in milk based products were more than adequate in Gain (12.1%) but were low in Nido (1.9%) and Wadi Fatima (2.3%) when compared with the recommended allowances. Both Nido and Wadi Fatima meet only 70% and 85% respectively of the recommended allowances of linoleic acid for infants. Since linoleic acid is dietary essential and its deficiency in infant may cause drying and flaking of skin, poor growth and lowered resistance to infections (Krause & Mahan, 1984).

The mineral composition (mg/100 kcal) of commercial baby foods is given in Table 4. The concentration of Ca was highest (159–189 mg) in milk based products and was lowest (101–145 mg) in milk-cereal blends. Mg content was highest (20 mg) in Cerelac with rice and was lowest (14 mg) in Milupa 2. The milk based products, Nido had highest content (180 mg) of K and lowest content (32 mg) of Na, whereas highest content (51 mg) of Na was found in Cerelac with wheat and lowest content (122 mg) of K was observed in Milupa 2. The concentration of Fe was highest (1.9 mg) in Cerelac with wheat and Cerelac with rice and was lowest (1.4 mg) in Nido. The highest content (0.1 mg) of Cu was present in Milupa 2. The concentration of Zn ranged from 0.8 mg/100 kcal in Gain and Cerelac with rice to 1.2 mg/100 kcal in Nido.

According to Codex standard (FAO/WHO, 1989), the recommended levels (mg/100 kcal) of Ca, Mg, Na, K, Fe, Cu and Zn for infant formulas

are 50 mg, 6 mg, 20 mg, 80 mg, 1 mg, 0.6 mg and 0.5 mg/100 kcal respectively. On comparing with the standard, Nido, Wadi Fatima and Gain (milk-based products) had highest content of Ca (378, 356 and 318% respectively of the standard), whereas Cerelac with wheat, Cerelac with rice and Milupa 2 (milk-cereal blends) supplied 202, 236 and 290% respectively of the standard. A high Ca intake may inhibit the intestinal absorption of Fe, Zn and other essential minerals (Greger, 1988). Mg content was also higher in all baby foods and ranged from 233–333% of the standard. There was no evidence that large intake of Mg was harmful to children with normal renal function, but impaired renal function resulting in Mg retention was often associated with hypermagnesemia including nausea, vomiting and hypotension (NRC, 1989). The baby foods provided Na (160–225%), K (153–225%), Fe (140–190%), Cu (67–166%) and Zn (160–240%) of the standard. Wadi Fatima was low in Cu and provided 67% of the standard. Similar high levels (% of standard) of Ca (466%), P (656%) and Fe (800%) have been reported in Farex commonly used in Pakistan (Khan & Eggum, 1979). The present results also agree with Dodd & Ratnani (1991) who found higher levels of Ca, Na, Fe, Mg and Zn in Indian commercial baby foods.

The daily recommended allowances for Ca, Mg, Na, K, Fe, Cu and Zn for 6 months-old infant are 600, 60, 200, 700, 10, 0.6 and 5 mg respectively (NRC, 1989). A 100 g of baby foods (milk based products vs milk cereal blends) tested in the present study can meet the daily requirement (% of RDA) of Ca (136–194% vs 72–120%), Mg (125–152% vs 118–142%), Na (84–99% vs 95–108%), K (119–134% vs 85–87%), Fe (74–92% vs

Table 4. Mineral contents (on dry basis) of commercial baby foods

Products		mg/100 kcal						
Name	Type	Ca	Mg	Na	K	Fe	Cu	Zn
Nido	Milk based	189	18	32	180	1.4	0.08	1.2
Wadi Fatima		178	16	36	160	1.6	0.04	1.1
Gain		159	15	39	162	1.8	0.09	0.8
Cerelac (wheat)	Milk-cereal	101	19	51	140	1.9	0.09	0.9
Cerelac (rice)	blends	118	20	44	144	1.9	0.09	0.8
Milupa 2		145	14	42	122	1.5	0.1	1.1

Table 5. Percent calories from different nutrients of baby foods

Products		Percent calories		
Name	Type	Protein	Carbohydrate	Fat
Nido	Milk based	20	30	49
Wadi Fatima		20	29	51
Gain		15	38	47
Cerelac (wheat)	Milk-cereal	15	67	18
Cerelac (rice)	blends	15	66	18
Milupa 2		15	42	43

74–81%), Cu (33–83% vs 66–83%) and Zn (82–124% vs 66–110%) respectively.

Quality evaluation

In a well-balanced infant formula, 7–18% of the total energy is usually derived from protein, 30–55% from fat and 35–50% from carbohydrates (AAP, 1976). Among the milk based products (Table 5) the quality of Gain was adequate in terms of protein, fat and carbohydrates. Both Nido and Wadi Fatima had lower concentration of calories from carbohydrates and higher levels of calories from protein than the recommended values. According to recommended nutrient density, a weaning food should provide 12%, 30% and 58% of the food calories from protein, fat and carbohydrates respectively (Abrahamsson, 1978). An imbalance of calories from different nutrient was observed in all milk-cereal blends (Table 5). Both Cerelac with wheat and Cerelac with rice provided 18% of the total calories from fat, indicating low energy density in these baby foods. Such an imbalance of calories from different nutrients may affect

the quality of the diet (Khan, 1989). Honey, a component of Milupa 2 (Table 1) has been reported to cause botulism in infants due to lack of immunity to resist the botulism spore development (Arnon, 1979).

Protein quality

The protein quality of a baby food depends on the pattern and bioavailability of amino acids and digestibility of protein sources used in its preparation (Sarwar, 1991). The protein quality of processed foods has been reported to be affected by heat processing (Bender, 1978; Khan & Eggum, 1979; Khan & Kissena, 1985), storage conditions (Pompei *et al.*, 1987) and by sucrose in the diet (Khan & Bender, 1974; Khan, 1975; Khan & Munira, 1978).

The true protein digestibility (TD), biological value (BV), net protein utilization (NPU) and net dietary protein calorie percent (NDP cal%) of commercial baby foods and control diet (casein) are presented in Table 6.

All the baby foods had TD above 90%. There was no significant difference between the means

Table 6. Protein quality of commercial baby foods

Products		True digestibility (%)	Net protein utilisation	Biological value (%)	Net dietary protein calorie (%)
Name	Type				
Nido	Milk based	93.0	0.74	80.0	14.8
Wadi Fatima		94.0	0.75	80.0	15.0
Gain		95.0	0.78	83.0	11.7
Cerelac (wheat)	Milk-cereal	94.0	0.68	73.0	10.2
Cerelac (rice)	blends	95.0	0.74	79.0	11.1
Milupa 2		95.0	0.70	74.0	10.5
Casein	Control	96.0	0.70	74.0	–

of TD of milk based products (93–95%), milk cereal blends (94–95%) and Casein (96%). The results agree well with TD of milk based formulas (95–97%) estimated by Khan and Kissana (1985). The NPU values of milk based products and milk–cereal blends ranged from 0.74–0.78 and 0.68–0.74 respectively. The difference between two types was statistically significant ($P < 0.01$). According to FAO/WHO Codex Alimentarius Commission (1989) the protein quality of infant foods, based on milk is measured against a casein reference. Table 6 shows that the NPU of Nido, Wadi Fatima and Gain (milk based products) varies from 0.74–0.78 and the values were higher than that of Casein (0.70). Highest NPU in Gain (0.78) indicates a better assortment of essential amino acids in the protein of this baby food. The present result agree well with NPU (0.75–0.78) of infant foods based on milk, produced in Sweden (Abrahamsson & Hambræus, 1977) and also with NPU (0.68–0.75) of baby foods used in Pakistan (Khan & Kissana, 1985). Although NPU values of milk based foods in the present study are higher than that of Codex standard, yet these values are far below the value of human milk (1.0). According to the guidelines of Protein Calorie Advisory Group (PAG) of the United Nations System (1972), on weaning foods, the NPU should never be less than 0.6. In the present study (Table 6) the NPU values of Cerelac with wheat, Cerelac with rice and Milupa 2 based on milk–cereal were found to be 0.68, 0.74 and 0.70 respectively and were comparable with NPU of Casein (0.70). The high NPU of Cerelac with rice (0.74) as compared to Cerelac with wheat (0.68) may be due to the better quality of rice protein, having better absorption and utilization of essential amino acids than wheat protein (Khan, 1985). Similar NPU values (0.68–0.71) and (0.69–0.77) of milk cereal blends have been reported respectively by Khan & Kissana (1985) and Abrahamsson & Hambræus (1977). It is interesting to note (Table 6) high TD and low NPU of Cerelac with wheat and Milupa 2. This suggests that protein of these baby foods has been damaged during processing and produced

some antinutritional compounds like premelanoïds (Finot, 1983). It is possible that amino acids were absorbed from the gut in non-metabolizable form and excreted in the urine resulting in high TD and low NPU of Cerelac with wheat and Milupa 2.

To enable a comparison of protein content in baby foods with varying protein quantity and quality, the net dietary protein calorie percent (NDP cal%) was calculated (Table 6). According to FAO (1965) the protein allowances in terms of NDP cal% are 8.0% and 7.8% for infant and toddler respectively. It is of interest that protein value of breast milk expressed in the same unit is also in the region of 8.0%. All the baby foods in the present study have NDP cal% between 10.2 and 15.0% and can meet the protein requirements of infants and toddlers.

According to FAO/WHO (1985) the RDA for reference protein during infancy is 14 g/day. Based on their NPU values, a 100 g of Nido, Wadi Fatima, Gain, Cerelac with wheat, Cerelac with rice and Milupa 2 can meet 140%, 138%, 109%, 80%, 86% and 93% of daily protein requirements of the infant.

In conclusion, the imbalance of calories and nutrients in some of the baby foods necessitates to encourage breast feeding at least during the first 6 months. The high protein contents may damage the kidney and the quantity and quality of protein in baby foods should be adjusted to simulate human milk. The protein quality may be improved by improving the processing and storage conditions. In order to reduce the risk of dental caries, baby foods in which sucrose has been replaced by glucose or lactose may be selected. Nutrition education of mothers and health workers on the selection and preparation of right type of baby foods and weaning practices will go a long way in improving the nutritional status of infants and children in the country.

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