Comparison of the Nutritional Values of Infant Formulas Available in Saudi Arabia

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Abstract

Introduction. Optimum growth and development are best achieved by breastfeeding, which is the safest source for infant feeding. Mothers in Saudi Arabia start to breastfeed their infants but soon introduce formula brands. Objective. To assess the safety and nutritional adequacy of the oldest formula brands available in the Saudi market. Methods. An observational study has compared between 5 types of infant formula brands; they were chosen based on their international popularity. Also, they are considered as the oldest formula brands available in the Saudi market. The contents of all the included formulas were carefully collected from their containers. The collected data were compared with the global standard requirements for infant formulas according to the guidelines. Results. All the infant formula brands had their contents within the optimal range as stated by the ESPGHAN (European Society for Paediatric Gastroenterology, Hepatology and Nutrition) guidelines. Some formulas did not provide elements like fluoride and nucleotides. Moreover, the mandatory elements and the most dominant ingredient in each formula were documented. Discussion. According to the results of our study, all included formula brands are considered safe and nutritionally adequate. By assuming that the elements that were not found in some brands meant an abnormal value, Bebelac and Liptomil are the most suitable infant formulas available in the Saudi market. Conclusions. Adequate nutrition during infancy is essential in each health organization. The nutritional status of infants should be studied to achieve lifelong health and well-being. All formula brands in this study were found to be safe and nutritionally adequate.

Keywords

brands, formula, infant health, nutrition

Received July 21, 2017. Accepted for publication August 8, 2017.

Introduction

The first 2 years of a child’s life provides a critical window of opportunity for ensuring appropriate growth and development through optimal feeding.¹ Optimum growth and development is best achieved by breastfeeding, which is the safest source for infant feeding.² Mothers in Saudi Arabia usually start to breastfeed their infants but soon introduce formula brands, and insufficient breast milk was identified as the most common reason for this early introduction of formula brands.³ In some cases, mothers are unwilling to breastfeed their infants because of their busy work schedule, because of some medical conditions, or due to breastfeeding difficulties.⁴,⁵ It is very critical to select the suitable formula based on the infant’s medical condition and the infant’s individual needs, after all formula milk is not as adequately safe as natural breast milk.⁴,⁶ Due to the large number of advertisements for infant formulas, and due to the various types of formulas that are widely available in the Saudi market, the appropriate choice of formula has been very difficult and confusing to both parents and physicians.⁷,⁸ This

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study was conducted on the most commonly available milk formulas to evaluate the nutritional adequacy and the safety of each formula and to compare between these formula brands accordingly.

**Objectives**

This study aims to assess the safety and nutritional adequacy of the oldest formula brands available in the Saudi market.

**Methodology**

This observational study was conducted in Madinah, Saudi Arabia, during March to April 2017. This research involved a comparison between 5 types of infant formula brands (nonspecially designed cow’s milk–based formulas) that are designed and marketed for feeding infants under 12 months of age; the formulas were chosen based on their international popularity. In addition, they are considered as the oldest formula brands available in the Saudi markets, NAN from Nestle since 1860, Bebelac from Nutricia since 1896, Liptomil from Liptomil since 1908, S26 GOLD from Wyeth since 1960, and Similac from Abbott since 1988. The composition of all the included formulas were carefully collected from the information written on the formulas’ containers. The collected ingredients of the included formulas were accurately documented using Microsoft Word 2010. Both macro- and micronutrient contents of each type of formula—energy, protein, lipid, carbohydrate, vitamins, and minerals—were expressed as the amount per 100 kcal of formula milk in one combined table by similar nutritional units for each ingredient labeled. The collected data were then compared with the global standard requirements for infant formulas according to the guidelines of The European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN).9 The ESPGHAN represents an optimal range of value for each nutrient, and these values indicate the normal range for safety and adequacy; so if a value does not fall within the normal range, it will consequently be represented as an abnormal value according to our guideline (the ESPGHAN).

**Results**

In Tables 1, 2, and 3, we can find that all the included infant formula brands (NAN, Bebelac, Liptomil, S26 GOLD, and Similac) had their contents within the optimal range as stated by the ESPGHAN guidelines. However, Similac did not have the following ingredients documented: fluoride and nucleotides. Both S26 GOLD and NAN formulas did not have fluoride included in their ingredients. However, both Liptomil and Bebelac formulas were found to have all the elements mentioned in the ESPGHAN guidelines. Nevertheless, the contents of all the 5 infant formulas were within the optimal range according to the ESPGHAN guidelines. Table 4 shows the mandatory elements included in each formula.

Regarding proteins, all the included formulas in our research had whey as the most dominant protein. Furthermore, it was found that S26 GOLD, Liptomil, and Bebelac have included casein in their formula composition. Only S26 GOLD has included α-lactalbumin.
Linoleic acid was found to be the most dominant type of fat in all the included formulas with the exception of Bebelac. All the formulas had linoleic acid, α-linolenic acid, arachidonic acid, and docosahexaenoic acid. In addition to the previous elements, Liptomil had also included eicosa-pentaenoic acid in its formula composition. Moreover, Bebelac had saturated trans fatty acid as the most dominant type of fat. Bebelac has also included monounsaturated and polyunsaturated fatty acids in its formula.

All the included formulas had lactose as the most dominant type of carbohydrate. Furthermore, Bebelac has included glucose, galactose, lactose (most dominant), maltose, and polysaccharides.

### Discussion

According to the results of our study, all the included formula brands were found to be safe and nutritionally adequate. There is lack of the following ingredients: fluoride and nucleotides. In comparison with the ingredients found in the ESPGHAN guidelines, there are 2 elements that were not found in some of the formulas, which are fluoride and nucleotides. Both Liptomil and Bebelac formulas were provided with all the elements. S26 GOLD and NAN both had a lack of fluoride. Similac formula had a lack of both fluoride and nucleotides. By assuming that the elements that were not found in some brands meant an abnormal value, Bebelac and

### Table 2. Formulas’ Mineral Contents Compared With the ESPGHAN Standards.

| Parameter     | Similac (mg/100 kcal) | S26 GOLD (mg/100 kcal) | Liptomil (mg/100 kcal) | Bebelac (mg/100 kcal) | NAN® (mg/100 kcal) | ESPGHAN Guidelines (mg/100 kcal) |
|---------------|-----------------------|------------------------|------------------------|-----------------------|-------------------|---------------------------------|
| Ca            | 78.04                 | 62.69                  | 69.23                  | 87.69                 | 64.18             | 50-140                          |
| P             | 42.37                 | 35.82                  | 43.08                  | 49.23                 | 35.82             | 25-90                           |
| Mg            | 9.36                  | 6.72                   | 7.85                   | 7.85                  | 8.51              | 5-15                            |
| Na            | 27.73                 | 23.88                  | 29.23                  | 26.15                 | 25.37             | 20-60                           |
| K             | 123.05                | 97.01                  | 103.08                 | 104.62                | 101.49            | 60-160                          |
| Cl            | 61.53                 | 64.18                  | 58.46                  | 64.62                 | 70.15             | 50-160                          |
| Zn            | 0.78                  | 0.90                   | 0.92                   | 0.8                   | 1.04              | 0.5-1.5                         |
| Fe            | 1.12                  | 1.19                   | 1.08                   | 0.82                  | 1                 | 0.3-1.3                         |
| Cu            | 78.97                 | 49.25                  | 69.23                  | 61.54                 | 77.61             | 35-80                           |
| Mn            | 20.56                 | 7.46                   | 11.85                  | 12                    | 19.40             | 1-50                            |
| I             | 0.90                  | 14.93                  | 13.85                  | 18.46                 | 19.40             | 10-50                           |
| Fluoride      | —                     | —                      | 9.85                   | ≤ 3                   | —                 | Not specified to 60             |

Abbreviation: ESPGHAN, European Society for Paediatric Gastroenterology, Hepatology and Nutrition.

### Table 3. Formulas’ Vitamin and Nucleotide Contents When Compared With the ESPGHAN Standards.

| Parameter     | Similac (IU/100 kcal) | S26 GOLD (IU/100 kcal) | Liptomil (IU/100 kcal) | Bebelac (IU/100 kcal) | NAN® (IU/100 kcal) | ESPGHAN Guidelines (IU/100 kcal) |
|---------------|-----------------------|------------------------|------------------------|-----------------------|-------------------|---------------------------------|
| A             | 256.39                | 328.36                 | 327.69                 | 282                   | 338.21            | 200-600                         |
| D3            | 74.45                 | 71.64                  | 67.69                  | 73.85                 | 55.52             | 40-100                          |
| E             | 3.47                  | 1.64                   | 1.54                   | 1.69                  | 1.54              | 0.5-5                           |
| K             | 8.57                  | 10                     | 6.92                   | 6.77                  | 8.28              | 4-25                            |
| C             | 10.44                 | 13.43                  | 20                     | 14.15                 | 14.25             | 8-30                            |
| B1           | 124.61                | 149.25                 | 89.23                  | 73.85                 | 111.94            | 60-300                          |
| B2           | 233.64                | 164.18                 | 156.92                 | 186.15                | 223.88            | 80-400                          |
| B6           | 62.31                 | 82.09                  | 89.23                  | 58.46                 | 70.15             | 35-175                          |
| B12          | 0.295                 | 0.27                   | 0.31                   | 0.28                  | 0.25              | 0.1-0.5                         |
| Niacin       | 1105.92               | 746.27                 | 769.23                 | 661.54                | 880.597           | 300-1500                        |
| Pantothenic acid (µg/100 kcal) | 623.05 | 522.39 | 615.38 | 529.23 | 940.299 | 400-2000 |
| Folic acid (µg/100 kcal) | 14.797 | 16.42 | 15.38 | 20 | 14.25 | 10-50 |
| Biotin (µg/100 kcal) | 3.89 | 2.99 | 2.92 | 2.15 | 2.54 | 1.5-7.5 |
| Choline (mg/100 kcal) | 15.58 | 14.93 | 11.85 | 18.46 | 18.06 | 7-50 |
| Nucleotide (mg/100 kcal) | — | 3.88 | 4.92 | 4.92 | 3 | 0-5 mg (optional) |

Abbreviation: ESPGHAN, European Society for Paediatric Gastroenterology, Hepatology and Nutrition.
Liptomil are considered the most suitable infant formulas available in the Saudi market. According to the ESPGHAN guidelines, essential contents include energy, protein, lipid, carbohydrate, vitamins, and minerals. And optional contents are taurine, nucleotides, phospholipids, long-chain polyunsaturated fatty acids, and carrageenan.

**Protein**

During the past 50 years, many studies have discussed the nutritional intake in full-term infants and the optimal protein-energy ratio and the safety and the consequences of infant milk formula feeding. All 5 formulas (NAN, Bebelac, Liptomil, S26 GOLD, and Similac) have their protein-energy ratios as recommended by the ESPGHAN guidelines (Tables 1-3). All these infant formulas are manufactured from cow’s milk; cow’s milk formulas are of 2 groups: whey-dominant formulas, which are modified to contain a higher proportion of whey to casein to mimic to some extent that proportion of human milk that is more digestible. These formulas are recommended in the first 4 to 6 months. The second type is casein-dominant formulas, which are modified to have a higher proportion of casein than that of human milk, as casein needs longer time to be digested. Thus, it is suitable to feed a full-term baby and the hungry baby, up to 1 year of age. These formulas can be stressful to the young infant’s immature organs, and they are recommended for infants from 3 to 6 months only. Similac, Bebelac, S26 GOLD, and Liptomil are whey-dominant formulas while Liptomil is a casein-dominant formula (Table 4). Whey-dominant formulas when compared to casein-based protein formulas are considered to be digested more easily and can enhance rapid gastric emptying. Of all the included infant formulas, S26 GOLD is the only formula that contains α-lactalbumin in addition to whey and casein (Table 4). Since newborns and infants are considered to be at higher risk of inadequate bioavailability of tryptophan, which is necessary for the optimal synthesis of serotonin in the brain, α-lactalbumin supplementation as a source of tryptophan can promote the neurobehavioral effects in adults, and S26 GOLD formula is considered to have the best protein content quality.

**Fat**

Infant formulas that include cow’s milk lipids and milk fat membrane extracts were found to be more similar to the structure and composition of human milk. However, the majority of infant formulas use vegetable lipids as they are much cheaper than cow’s milk lipids. Similac, S-26 GOLD, Bebelac, and Liptomil have vegetable oils as their sole source of fat. NAN has both vegetable and animal sources of fat. Similac’s vegetable sources of fat include high oleic sunflower oil, oil soy oil, coconut oil; S26 GOLD includes palm oil, high oleic sunflower oil, soybean oil, coconut oil; Liptomil includes palm oil, sunflower oil, rapeseed oil, coconut oil; Bebelac includes palm oil, sunflower oil, erucic acid, rapeseed oil, coconut oil, and single cell oil; and NAN includes palm olein, sunflower oil, low erucic acid, rapeseed oil, coconut oil, and fish oil (from tuna fish; Table 4). The amount of linoleic acid in breast milk varies according to maternal dietary intake, but usually represents about 8% of total fatty acids. Regarding infant formulas, values of

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**Table 4. The Mandatory Elements Included in Each Formula.**

| Parameter  | Similac | S26 GOLD | Liptomil | Bebelac | NAN |
|------------|---------|----------|----------|---------|-----|
| Protein    | Whey    | Whey     | Whey     | Whey    | Whey |
| Alpha-lactalbumin | Casein |          |          |         |     |
| Alpha-lactalbumin | Casein |          |          |         |     |
| Fat        | LA      | LA       | LA       | LA      | LA  |
| ALA        | ALA     | ALA      | ALA      | ALA     | ALA |
| AA         | AA      | AA       | AA       | AA      | AA  |
| DHA        | DHA     | DHA      | DHA      | DHA     |     |
| Eicosapentaenoic acid |          |          |          | Saturated trans fatty acid | |
| Carbohydrate | Lactose | Glucose  | Lactose  | Glucose | Lactose |
|            |         | Galactose| Lactose (most) | Galactose |     |
|            |         | Maltose  | Polysaccharide | Maltose |     |

Abbreviations: LA, linoleic acid; ALA, α-linolenic acid; AA, arachidonic acid; DHA, docosahexaenoic acid.
linoleic acid are 8% or more of total fatty acids. Infant formulas use the following polyunsaturated vegetable oils: corn, safflower, and soybean oils, which contain abundant amounts of linolenic acid (usually between 45% and 70% of total fatty acids). All formulas included in our study have their linoleic content levels in the optimal range. All formulas included in our study have included α-linoleic acid in their formulas and have them in the optimal range (Table 4). It has been found that blood levels of arachidonic acid and docosahexaenoic acid are decreased in infants fed with formulas without these fatty acids compared to infants that are breastfeeding. Long-chain polyunsaturated fatty acids are known to be powerful mediators of metabolism, but it has not been established whether there is a potential of short- or long-term effects on infants. All the formulas included in our study have arachidonic acid and docosahexaenoic acid included and their content levels are as recommended by the ESPGHAN guidelines. Fatty acids in fish oil predominantly include ω-3 fatty acids, which are eicosapentaenoic acid (20:5n-3) and docosahexaenoic acid (DHA; 20:6n-3). According to a study by Lucas et al, the data on 300 children from 7.5 to 8 years of age, who had been premature infants, concluded that the fatty acids included in breast milk are associated with higher intelligence quotient. Nonetheless, the subject of whether to add these fatty acids to infant formulas is still in debate. NAN has included fish oil from tuna fish in its formula composition. It has been studied that it is acceptable for lactose to be used as a sole source of carbohydrates in infant formulas and that it is safe and appropriate for use in healthy term infants. Regarding Bebelac, it has included 4 additional ingredients in its formula composition, which are glucose, galactose, maltose, and polysaccharides (Table 4).

**Carbohydrates**

Breast milk contains predominantly lactose as a source of carbohydrates. Lactose also plays a role in the process of absorption of calcium and minerals. Many bioactive compounds, such as oligosaccharides, have been found to be attached to lactose in breast milk. Regarding infant formulas, the recommended amount of carbohydrates is between 9 g/100 kcal and 14 g/100 kcal of total carbohydrates. Carbohydrates accepted for use in infant formulas include lactose, maltose, sucrose, glucose, maltodextrins, glucose syrup or dried glucose syrup, precooked starch, and gelatinized starch. All the included formulas in our study have their carbohydrate values in the optimal range. The addition of glucose to infant formulas has not been shown to provide any additional benefit and may adversely increase the osmolarity and the probability of occurrence of the Mallard reaction during the processing of infant formulas. Similac, S-26 GOLD, NAN, and Liptomil have used lactose as the sole carbohydrate source in their formulas. Bebelac also has included lactose but not as a sole source (Table 4). It has been studied that it is acceptable for lactose to be used as a sole source of carbohydrates in infant formulas and that it is safe and appropriate for use in healthy term infants. Regarding Bebelac, it has included 4 additional ingredients in its formula composition, which are glucose, galactose, maltose, and polysaccharides (Table 4).

**Vitamins**

Human breast milk contains adequate amounts of most vitamins to support normal infant growth, except for vitamins D and K. Formula-fed infants often have higher serum concentration of vitamin D metabolites than breastfed infants. All formulas included in this study had their vitamins in the optimal range as recommended by the ESPGHAN guidelines.

**Minerals**

Table 1 to 3 show that all 5 formulas were fortified with all the essential minerals except for Similac, S26 GOLD, and NAN, which lack fluoride. The proper amount of fluoride from infancy through old age helps prevent and control tooth decay. However, an Expert Panel recommended a minimum level of zero for the fluoride content of infant formulas. It is recognized that fluoride promotes dental health, and there is a question about whether the benefit of fluoride intake during early infancy warrants the risk of dental fluorosis. Bebelac and Liptomil contain an optimal level of fluoride, on the lower extreme. Fluoride was found below the Saudi Arabian Standards Organization recommended range in all the imported bottled-water brands and 2 local brands. In a study conducted in Iraq, the Similac formula brand has shown different values, which may indicate that there are differences in the ingredients of the same formula brand between Saudi Arabia and Iraq. This leads us to ask, why are there differences between elements in the same brand in each country?

**Limitations**

There are more than 18 formula milk brands in Saudi Arabia, and our study was confined to only 5 formula brands. In our study we chose these formulas based on their international popularity and based on which
formulas are considered to be the oldest in the Saudi market. Future studies that include the top-selling formula milk brands in Saudi Arabia are recommended.

Conclusions
In fact, infants’ health is a cornerstone in each health organization. Nutritional status should be studied to save our infants. Fortunately, all brands in this study were safe and nutritionally adequate, but a few ingredients were not found in some brands, which did not affect the total result. The study explains each ingredient separately with comment about the normal amount and the impact of each ingredient to the infants’ health. We have to encourage breast milk feeding, and formula should be equivalent to breastfeeding.

Acknowledgments
The authors gratefully acknowledges Hisah Abdullah Alturki, Ahmed Mohammed Madkhali, and Lojain Ibrahim Alsubaihi.

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A Allogmani: Contributed to design; contributed to acquisition, analysis, and interpretation; drafted manuscript; critically revised manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

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