Libyan Journal of Medical and Applied Sciences LJMAS
Online ISSN: 3006-1113
Volume 3, Issue 3, 2025, Page No: 131-137
Website: https://ljmas.com/index.php/journal/index

Assessing the levels of certain elements (Na, K, Ca, Mg, Fe, and Zn) in a variety of baby formula brands available in Libya

Badria. A. Salem [1 *], Rowaida M. Younes [2]
[1,2] Department of Chemistry, Faculty of Sciences, Almeregib University, Al-khoms, Libya

[*]*Corresponding author:* Frausalem@gmail.com

Received: June 02, 2025 Accepted: September 03, 2025 Published: September 08, 2025

Cite this article as: B, A, Salem., R, M, Younes. (2025). Assessing the levels of certain elements (Na, K, Ca, Mg, Fe, and Zn) in a variety of baby formula brands available in Libya. Libyan Journal of Medical and Applied Sciences (LJMAS). 2025;3(3):131-137.

Abstract

According to the World Health Organization, breastfeeding is the healthiest and safest option for newborns. Infant formulas continue to be a great substitute for breast milk and serve a crucial function in the baby's nutrition. Purified bovine milk, protein, lactose, vegetable oils, and vitamin/mineral premixes are the main components of baby formulae. Due to the possibility that adding extraneous ingredients or serving sizes may have an impact on a baby's physiological and metabolic processes. In ten samples of powdered infant milk formulas (0–6 months) available on the Libyan market, the concentration of many elements, including sodium, potassium, calcium, iron, and magnesium, was measured using a flame photometer. The results were compared to the label values.

The results of this investigation, which took place in 2024, showed that while the contents of zinc, iron, and magnesium were lower than those stated on the label in all formulas and below Codex alimentarius requirements, the contents of sodium, calcium, and potassium were more than those declared on the label in all formulas and met Codex alimentarius requirements.

Keywords: Infant Milk, Minerals, Iron, Calcium, Flame Photometer.

تقييم مستويات بعض العناصر (الصوديوم، البوتاسيوم، الكالسيوم، المغنيسيوم، الحديد، والزنك) في تركيبات مختلفة من حليب الأطفال المتوفرة في ليبيا

بدرية عبد السلام سالم[1*]، رويدا مفتاح يونس[2]
[2،1] قسم الكيمياء، كلية العلوم، جامعة المرقب، الخمس، ليبيا

الملخص

وفقًا لمنظمة الصحة العالمية، تُعدّ الرضاعة الطبيعية الخيار الأكثر صحةً وأمانًا للمواليد الرضع. ولا تزال تركيبات حليب الأطفال بديلاً ممتازًا لحليب الأم، وتؤدي دورًا أساسيًا في تغذية الطفل. ويُتكون حليب الأبقار من البروتين، واللاكتوز، والزيوت النباتية، ومُركّبات الفيتامينات والمعادن هي المكونات الرئيسية لتركيبات حليب الأطفال. ونظرًا لاحتمالية تأثير إضافة مكونات أو أحجام غير ضرورية على العمليات الفسيولوجية والأيضية للطفل، فقد تم قياس تركيز العديد من العناصر، بما في ذلك الصوديوم، والبوتاسيوم، والكالسيوم، والحديد، والمغنيسيوم، في عشر عينات من تركيبات حليب الأطفال المُجفف (من 0 إلى 6 أشهر) المتوفرة في السوق الليبي، باستخدام مقياس ضوئي لهبي. وقورنت النتائج بالقيم المُدوّنة على المُلصق. أظهرت نتائج هذا البحث الذي أجري في عام 2024م أن محتويات الزنك والحديد والمغنيسيوم كانت أقل من تلك المذكورة على الملصق في جميع التركيبات وأقل من المتطلبات الموصى بها من قبل منظمة الصحة العالمية ومنظمة الزراعة والأغذية، بينما محتويات الصوديوم والكالسيوم والبوتاسيوم كانت أكثر من تلك المذكورة على الملصق في جميع التركيبات وتتوافق مع المتطلبات الموصى بها.

الكلمات المفتاحية: حليب الأطفال، معادن، حديد، كالسيوم، المقياس الضوئي اللهبي.

Introduction

Literature Review

Since newborns have limited dietary options, appropriate nutrition is crucial for their growth and development throughout the first year of life. If a vital nutrient is absent or unavailable, the body cannot perform its functions as intended **[2]** Developed and marketed for feeding to infants, infant formula is a synthetic form of breast milk. It is based on the milk of cows or other animals, or a mixture thereof, and other ingredients that have been proven to be suitable for infant feeding. Strict quality assurance compliance is required at two levels: first, during processing in the industry, and second, during preparation at home **[1].**

Despite the fact that breast milk has greater health advantages than baby formula, many parents nevertheless prefer the latter. Good baby formula is implied by milk that is both nutritionally and microbiologically sound. The original flora of raw milk and the processing circumstances have an impact on microbiological quality **[3].** In research conducted by **[4],** the physiochemical parameters (moisture, protein, fat) and important elements (Ca, Cu, Fe, Mg, Mn, Na, K, Zn) of newborn milk formulae were measured and compared with information verified by the product makers. There are no discernible changes between the measured and labeled values, according to the data. According to this survey, most milk formulae available in Kuwaiti commercial marketplaces satisfy children's nutritional needs. in the year of their initial growth.

[5] examined the protein, fat, carbohydrate, lactose, calcium, iron, and zinc levels of fifteen samples of baby formula in Saudi Arabia. While the lactose concentrations of the majority of the milk formulae under investigation were greater than those listed on the label, the carbohydrate and fat amounts were lower. The label's specified amounts of protein and minerals were met.

[6] used flame atomic absorption spectrometry to analyze eleven infant formulae for the level of Ca, Mg, Na, and K in Lublin. The current study's findings were contrasted with values listed on product packaging by the manufacturers. Certain differences between the compared numbers were discovered in a few instances.

Additionally, research was conducted for this article to ascertain the major and minor element contents of several milk samples that were sold in Romania's largest grocery chains. The components in this matrix were quantitatively determined using Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). Following the samples' chemical mineralization with nitrogen acid, analyses were carried out. 0.4 to 7.03 ng/g were the detection limits, according to **[7].**

[8] used energy-dispersive X-ray fluorescence (EDXRF) spectrometry to measure the amounts of K, Ca, Fe, Zn, Br, Rb, and Sr in 28 newborn milk formulas that are widely available in the Greek market. These results are in line with the safety levels that are currently advised.

Materials and methods

Sampling

Ten samples of infant formula milk, also known as regular formula, ranging in age from birth to six months, were gathered from pharmacies in the Libyan market for the study. These samples are listed in Table 1 and were selected based on market availability and usage. All of the samples were powder cow milk-based formulae, and each sample underwent three tests using a Flame Photometer (Type BWB).

Preparation of Samples

The samples were broken down in accordance with **[9]** instructions. After drying, it was ashtened for four hours at 550°C. 10 ml of 6 N HCl were added to the sample when it had cooled, and the mixture was evaporated until it was completely dry. The residue was dissolved in 0.1N HNO_3 and filled to the 100 ml flask mark with deionized water. A flim atomic absorption spectrophotometer was used to determine the analysis.

Table1. Samples and country of origin of infant formula used in the study

sample No	country of origin
1	Switzerland
2	Belgium
3	Europe
4	Belgium
5	Switzerland
6	Holland
7	France
8	France
9	Switzerland
10	France

Result and Discussion

Table 2. Elements contents mg/100g the value on label

Elements / Samples	Given value on label (mg/100g)					
	Na	K	Ca	Mg	Fe	Zn
1	150	520	350	40	5.80	4.50
2	182	511	425	44	3.30	4.40
3	159	518	438	39	3.90	3.50
4	180	580	500	41	5.20	3.80
5	150	520	350	40	5.80	4.50
6	155	500	385	46	6.00	4.60
7	120	515	450	55	6.00	6.00
8	159	515	445	39	3.80	3.50
9	180	520	400	40	5.00	4.50
10	150	520	350	40	5.80	4.50

Table 3. Results of the Elements contents (mg/100g) in 10 infant's milk powder Samples in market Libya.

Elements / Samples	Na *Mean ± SD	K Mean ± SD	Ca Mean ± SD	Mg Mean ± SD	Fe Mean ± SD	Zn Mean ± SD
1	115.42±2.848	552.53±7.572	325.37±13.83	27.13±2.033	0.28±0.029	1.7±0.100
2	209.93±6.799	621.1±7.850	636.33 ±20.805	32.53±0.475	0.09±0.017	2.2±0.200
3	213.23±2.554	623.8±13.809	638.9±6.842	34.97±0.534	0.30±0.006	1.8±0.100
4	226.77±5.508	645.5±8.118	689.27±9.646	24.47±0.185	2.05±0.121	1.6±0.000
5	223.23±4.954	683.7±17.156	656.77±18.20	31.01±0.429	0.10±0.000	3.5±0.100
6	211.71±4.2	650.93±10.005	725.93±20.27	45.08±0.465	0.15±0.01	3.2±0.100
7	171.53±3.758	627.93±8.975	681.2±3.727	49.81±0.272	0.15±0.000	4.0±001.0
8	192.92±2.972	523.03±4.835	628.63±19.225	45.40±0.542	0.20±0.000	1.5±.001
9	142.81±6.199	432.53±16.359	591.07±10.09	20.31±0.485	0.30±0.006	2.0±000
10	110.63±3.347	309.9±3.995	556.0±1.153	15.25±0.283	0.35±0.006	5.3±0.003

*Values are Means ± Standard Deviation. Values in the same column with the same superscripts are not significantly different ($p< 0.05$).

Determination of Sodium Level

Sodium controls blood pressure and volume and aids in the regulation of nutrition absorption **[11].** The sodium content of baby formulae ranged from 110.63±3.347 to 115.42±2.848 mg/100g, as shown in Table (3) and Figure (1). Sample No. 4 had the highest sodium content, at 115.42±2.848 mg/100g, while Sample No. 10 had the lowest, at 110.63±3.347 mg/100g. With the exception of Samples No. 9 and 10, where the sodium amounts were less than those stated on the label, all formulae had higher sodium concentrations than those claimed (Table 2). The Codex Alimentarius specifies that the sodium concentration in baby formulae ranges from 20 to 60 mg/100 kcal, or 133.2 to 399.6 mg/100g**[14].** With the exception of samples nos. 1 and 10, which had low amounts, all of the samples in this investigation had sodium contents that met Codex alimentarius criteria. Research by **[4]** reported salt concentrations ranging from 75 to 108 mg/100 g, which is less than what the current investigation found**.** Similar to this study, another Brazilian study found that the salt level ranged from 118 to 180.3 mg/100g. **[10].**

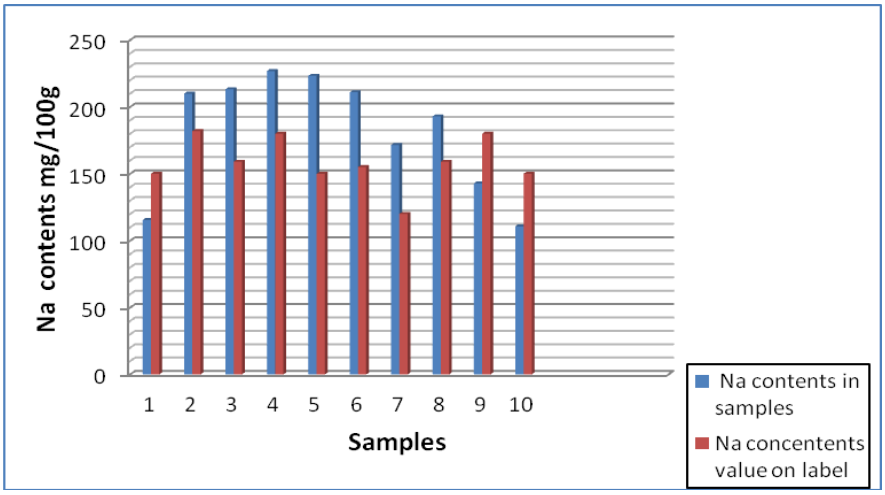

Figure 1. contents of Sodium in infant's milk powder Samples(mg/100g)

Determination of Potassium Level

The primary intracellular cation is potassium, which also plays a role in intracellular osmotic activity and partially regulates intracellular fluid volume. **[11].** The potassium concentrations of baby formulae varied from 3.995±309.9 to 683.7±17.156 mg/100g, as indicated by table (3) and figure (2). The potassium content in sample no. 5 was found to be at its greatest value of 683.7±17.156 mg/100g, while sample no. 10 had the lowest value of 3.995±309.9 mg/100g. With the exception of Samples No. 9 and No. 10, which had lower potassium amounts than those listed on the label, all formulations had higher potassium values than those listed (Table 2). The Codex Alimentarius specifies that the potassium concentration in baby formulae ranges from 60 to 160 mg/100 kcal, or 399.6 to 1065.6 mg/100g**[14]**. In this analysis, the potassium amounts of every sample met Codex standards. All samples met Alimentarius criteria, with the exception of Sample No. 10. The potassium concentrations in the Egyptian study ranged from 643.05 to 842.35 mg/100 g, which was greater than the findings of our study by **[10&12]** found that the potassium concentration in this research ranges from 331.7 to 396.9 mg/100g.

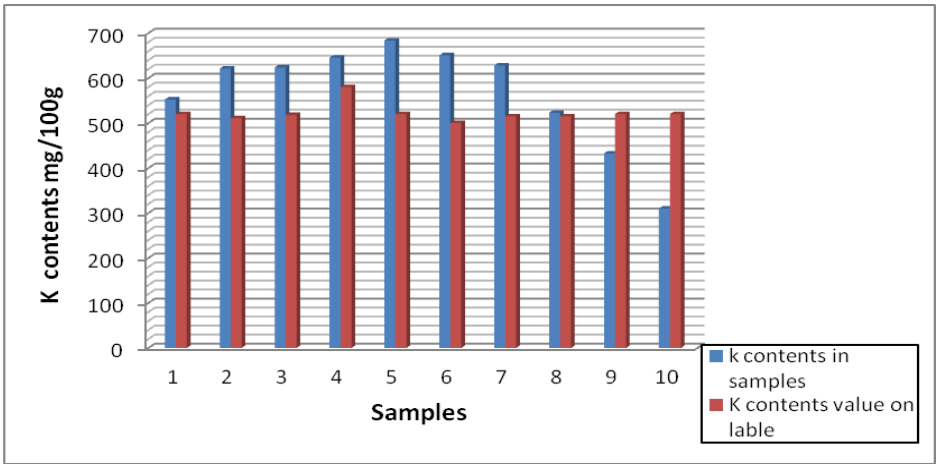

Figure 2. contents of Potassium in infant's milk powder Samples(mg/100g)

Determination of Calcium Level

Infant formula with adequate amounts of calcium is very beneficial for infant growth and development, because approximately 99% of calcium is found in the skeleton with only small amounts found in plasma and extravascular fluid **[4].** The calcium content of infant formulae ranged from 325.37±13.823 to 725.93±20.237 mg/100g, as shown in Table (3) and Figure (3). With the exception of Sample No. 1, which had somewhat less calcium than what was stated on the label, all formulae had higher calcium amounts than what was stated on the label (Table 2). Sample No. 6 had a high Ca concentration of 725.93±20.237, whereas Sample No. 1 had a low Ca content of 325.37±13. 823.Infant formulae listed in the Codex Alimentarius have calcium concentrations ranging from 50 to 140 mg/100 kcal, or 333 to 932.4 mg/100g **[14].** Except for Sample No. 1, which had a

somewhat low concentration, all of the samples in this investigation had calcium contents that complied with Codex Alimentarius criteria.

Determination of Magnesium Level

Magnesium is an essential component of many different enzymes, modulators of physiological processes, and plays a crucial role in many aspects of intermediate metabolism. **[11].** An insufficient amount of magnesium in neonates might result in SIDS. However, according to **[13],** taking more magnesium than is advised might cause nausea**, [10].** The magnesium concentrations of baby formulae varied from 15.25±0.283 to 0.272±49.81 mg/100g, as indicated by tables (3) and figure (4). Sample No. 10 had the lowest magnesium concentration, whereas sample No. 7 had the highest. All formulae had lower magnesium amounts than those listed on the label, with the exception of the Bebelac formula, which had greater magnesium concentrations. Infant formulae listed in the Codex Alimentarius have magnesium concentrations ranging from 5 to 15 mg/100 kcal, or 33.3 to 99.9 mg/100g **[14]**. The majority of the study's samples had low magnesium concentrations. Low magnesium concentrations were found in another investigation, ranging from 30 to 32 mg/100g**.** Research by Kotb et al. (2016) found that the magnesium concentrations in the range of 44.62 to 63.67 mg/100g were greater than those found in [10].

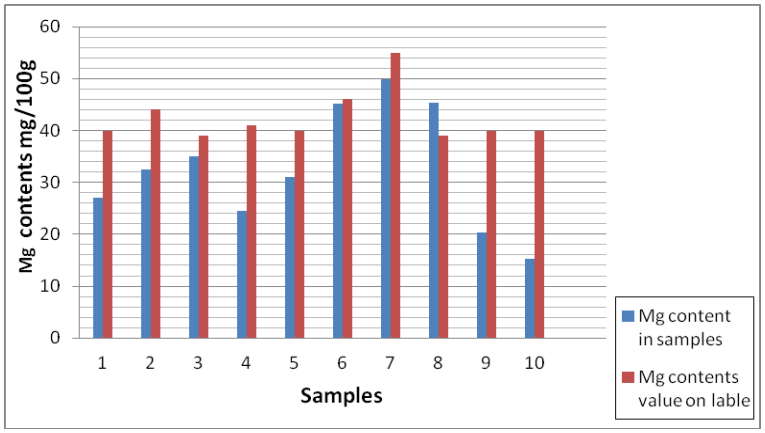

Figure 4. contents of Magnesium in infant's milk powder Samples(mg/100g)

Determination of Iron Level

For the transportation, storage, and use of oxygen during childhood, iron is necessary. **[10].** The iron concentration of baby formulae varied from 0.09±0.017 to 2.05±0.0121 mg/100g, as indicated by table (3) and figure (5). The sample No. 4 had the greatest iron concentration value, 2.05±0.00 mg/100g, whereas sample No.2 had the lowest iron concentration value, 0.09±0.017 mg/100g. According to Codex Alimentarius, the iron concentration in baby formulae ranges from 0.3 to 1.3 mg/100 kcal, or 1.99 to 8.66 mg/100g**[14].** All samples had low iron concentrations, with the exception of Sample No.4, which complies with Codex Alimentarius standards.

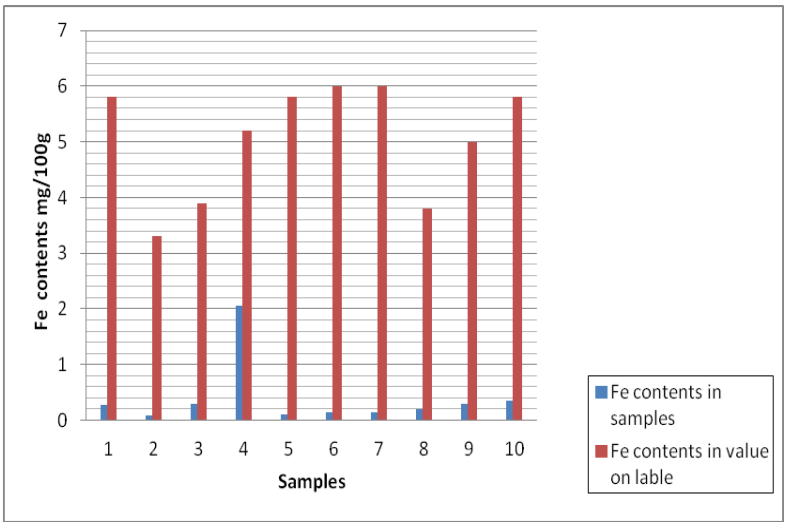

Figure 5. contents of iron in infant's milk powder Samples(mg/100g)

Determination of Zinc Level

Zinc is required for the preservation and functioning of structural enzymes, genic expression control, neurological development, and gastrointestinal digesting **[10],** On the other hand, too much zinc can lower the body's iron content and cause neutropenia or microcytic anemia. Furthermore, **[12]** found that zinc and magnesium compete for absorption in the intestines and in the structural elements of the bone.Figure (6) and Table (3). The zinc concentration in samples 1,3,4 and 8 was comparable, ranging from 0.±1.501 mg/100g to 0.1±1.800 mg/100g. The Zinc levels in baby formulae varied from 1.5±0.001 to 5.3±0.003 mg/100g.With the exception of Sample No. 10, which showed 5.3±0.003 mg/100g, which was higher than the 4.5 mg/100g stated on the label, the zinc concentrations were lower than those claimed on the label in all formulae (Table 2). Infant formulae listed in the Codex Alimentarius have Zinc concentrations ranging from 0.5 to 1.5 mg/100 kcal, or 3.33 to 9.99 mg/100g**[14].** Except for Samples No. 7 and 10, which conform to Codex Alimentarius standards, all of the study's samples had low zinc concentrations. Zinc level was found to be lower in another study by **[4],** ranging from 0.8 to 1.3 mg/100g. Zinc levels were greater in another investigation by **[12]**, reporting 10.59 mg/100g.

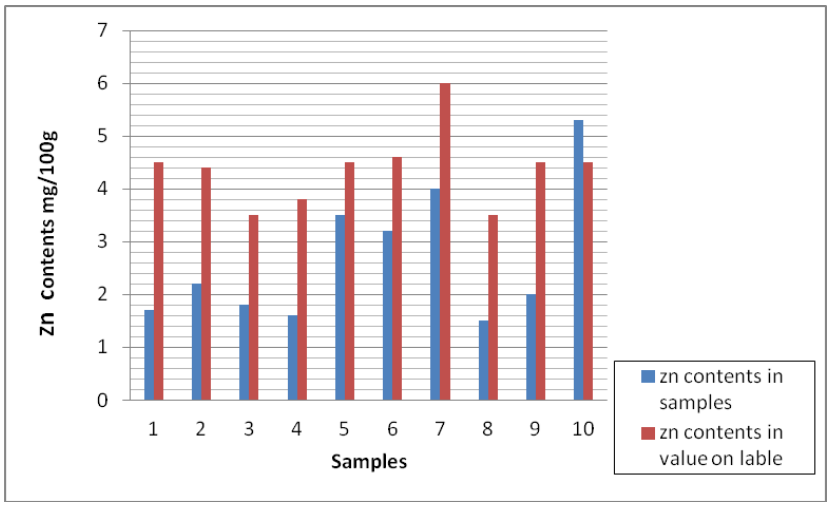

Figure6. contents of Zinc in infant's milk powder Samples(mg/100g)

Conclusion

The following conclusions are drawn from this study's use of a flame photometer to measure the following elements (Na, K, Ca, Mg, Fe, and Zn) in 10 samples of different brands of baby milk powder available in Libya:

1. Generally speaking, the majority of the samples in this investigation met Codex alimentarius standards for sodium, potassium, and calcium content. However, the amounts of magnesium, zinc, and iron were low.
2. The quantities of sodium, calcium, and potassium were higher than those listed on the label in every formula, whereas the levels of zinc, iron, and magnesium were lower.

Recommendation

1. We must promote nursing with breast milk. Infant formulae are an excellent alternative to breast milk in situations where women are unable to nurse; these formulas should be comparable to nursing.
2. To ensure safer and healthier powdered baby formula products, the nutritional content of all infant formula products must adhere to the applicable requirements advised by the Codex Alimentarius Commission and the Global Standard for the content of baby Formula.
3. A vital stage in quality control and newborn formula is nutrition analysis. To guarantee the authenticity of the ingredients stated on their label, further research is needed to assess the chemical composition of baby formulae on a larger number of samples and a wider variety of brands.

References

1. Mingruo Guo. (2014). Human Milk Biochemistry and Infant Formula Manufacturing Technology. Woodhead Publishing Series in Food Science, Technology and Nutrition: No. 261.
2. Michaelsen, K. F. (2003). Feeding and nutrition of infants and young children. Copenhagen, WHO-Regional
3. Abdelkhalek, A., Elsherbini, M., Eletriby, D., & Sadak, A. (2016). Quality assessment of imported powder milk at Mansoura city, Egypt. Journal of Advanced Veterinary and Animal Research, 3(1), 75-78.

4. Bu-Hamdi, M. A., Al-Harbi, M., & Anderson, A. K. (2016). Assessment of the nutritionally essential minerals and physiochemical properties of infant milk food commercially available in Kuwait. Int. J. Agric. Sci. Food Technol, 2(1), 001-008.
5. Alfaris, N. A., Alothman, Z. A., Aldayel, T. S., Wabaidur, S. M., & Altamimi, J. Z. (2022). Evaluation and comparison of the nutritional and mineral content of milk formula in the Saudi Arabia market. Frontiers in Nutrition, 9, 851229.
6. Kwiecień, M., Winiarska-Mieczan, A., Samolińska, W., Kiczorowska, B., & Rusinek-Prystupa, E. (2017). The content of magnesium, calcium, sodium and potassium in infant formulas. Journal of Elementology, 22(1).
7. Birghila, S., Dobrinas, S., Stanciu, G., & Soceanu, A. (2008). Determination of major and minor elements in milk through ICP-AES. Environmental Engineering & Management Journal (EEMJ), 7(6).
8. Papachristodoulou, C., Tsiamou, M. C., Sakkas, H., & Papadopoulou, C. (2018). Determination of minerals in infant milk formulae by energy dispersive X-ray fluorescence spectrometry. Journal of Food Composition and Analysis, 72, 39-47.
9. Oddy, W. H. (2001). Breastfeeding protects against illness and infection in infants and children: a review of the evidence. Breastfeeding Review, 9(2).
10. Almeida, C. C., Baiao, D. D. S., Rodrigues, P. D. A., Saint'Pierre, T. D., Hauser-Davis, R. A., Leandro, K. C., ... & Conte-Junior, C. A. (2022). Macrominerals and trace minerals in commercial infant formulas marketed in Brazil: Compliance with established minimum and maximum requirements, label statements, and estimated daily intake. Frontiers in Nutrition, 9, 857698.
11. Bruxelles/ Brussels – Belgium. (2003). Report of the Scientific Committee on Food on the Revision of Essential Requirements of Infant Formulae and Follow-on Formulae. Scientific Committee on Food, PP.1-213.
12. Kotb, M. A., Farahat, M. F., & El-Daree, H. B. (2016). Chemical composition of infant milk formulas sold in Alexandria, Egypt. Canad J Clin Nutr, 4(1), 4-17. Molska,A., Gutowska,I., Bosiacka,B., Noceń,I and Chlubek,D.(2014). The Content of Elements in Infant Formulas and Drinks Against Mineral Requirements of Children. Biol Trace Elem Res, Vol.158, PP.422–427.
13. WHO/FAO CODEX Codex Alimentarius Commission. Standard for infant formula and formulas for special medical purposes intended for infants: WHO/FAO CODEX STAN 72- 1981. Amendment: 1983, 1985, 1987, 2011 and 2015.