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STUDY ON THE BIOCHEMICAL COMPONENTS OF INFANT FORMULA FOR THE FIRST AND SECOND AGE GROUP OF NAJAF GOVERNORATE AND COMPARISON WITH BREAST MILK

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ABSTRACT : The aim of this study was to find out the differences between infant formula samples and breast milk during the first year of lactation stage for the biochemical compounds. 240 samples of breast milk were collected from healthy mothers aged 18-30 (month 3-11) from breastfeeding from 44 mothers as volunteers to give fixed samples per month for analysis. Infant formal milk samples were collected from companies (Bebelac1, 2; Similac1, 2 and Guigos1,2) from the local market in Najaf governorate. Moisture, ash, protein, lactose and fat were measured. The results showed that the differences between breast milk and Infant formula at the two periods (less than six months and beyond),where infant milk formula contain protein and fat in the first stage higher than breast milk while in the second stage, the fat percentage has decreased in the formula to become breast milk is the highest.The percentage of ash and moisture (after recovery from infant formula) was higher in infant formula than breast milk during the period of lactation (although there were no significant differences in ash). As well as for lactose, infant formula was higher during the study period with significant differences in both stages for the first year.

Key words : Breast milk, infant milk formula, milk proteins, milk fat, lactose.

INTRODUCTION

Breast milk considered the essential and optimum food and the fist in the world for infant because it contains the nutrients necessary for its rapid growth and development (Zou ***et al***, 2016). During the first few weeks after birth, the composition of breast milk varies significantly from colostrum, which is composed of high protein concentrations, fat-soluble vitamins, minerals and Immunoglobulin, to mature milk made from water, carbohydrates, fats, proteins and micronutrients needed for infant growth and child development (Levi ***et al***, 2018). Breast milk is very essential especially during the first six months of the infant's life. It is the integrated diet of the growing infant, providing immunity, energy, fat and other important elements for the development of different body organs (Lam ***et al***, 2018; Chajduk ***et al***, 2018). Breast milk is a complex combination of a dynamic nature that changes over time and adapts to the changing needs of a growing child. Pro-milk is characterized by the high content of lactose sugar that infuses the infant's thirst, followed by a creamy hind-milk with high fat content and proteins to meet the baby's needs (Perrone ***et al***, 2019 and Martin ***et al***, 2016). The breast milk has a general composition of water 87%, fat 3.8%-4%, protein 1.0%, lactose sugar 7%. The latter and the fat respectively provided 40% and 50% of the total energy supplied by milk (Martin ***et al***, 2016; Clarke and Trivedi, 2019). The components of breast milk can vary among individuals, depending on several factors, including genetic, health status, diet, mother age during pregnancy, duration of pregnancy, geographical location and time of breast feeding (Martínez ***et al***, 2019; Visentainer ***et al***, 2018). Infant Milk Formula (IMF) considered as a powder or liquid intended to serve as a substitute for human milk (Lönnerdal, 2016). It is known as industrially produced food as an alternative to breast milk (Cama-Moncunill ***et al***, 2018). It also represents as a milk produced for use during the first year of life (Lien ***et al***, 2018). These formulas are commonly available as powders, ready-to-feed liquids and liquid concentrates. These formulas provide a relatively good alternative to breast milk, as not all infants can get breastfeeding from the mother (Lai ***et al***, 2018). Although, breast milk is the best choice in infant feeding globally, however, breast milk substitutes (BMS) are sometimes necessary when HBM is unavailable for any cause or inappropriate for the infant (Wu ***et al***, 2017). Since the IMF plays an indispensable role in infant feeding, formulas should be similar to human

milk in terms of its nutrient content, both large and micro (Cama-Moncunill ***et al***, 2018). As the Infant Formula (IF) industry develops, manufacturers should take into consideration the infant's essential nutritional requirements and enrich the formulas with the functional components found naturally in human milk (HM) (Ros ***et al***, 2018). The continued practice of breastfeeding is influenced by several factors, including health, economics, individual culture as well as social factors (Rossen ***et al***, 2016), as well as the policy that supports and promotes these practices and the systematic marketing of BMS.The promotion of formulas negatively affects the choice of mothers and their ability to breastfeed their babies ideally, which called the World Health Assembly and the International Marketing Law (BMS) in 1981 to respond to the high child mortality rate (Hernández-Cordero ***et al***, 2019). Although, every effort has been made to make infant formula approach to human breast milk in order to ensure the growth and development of the natural baby, such as fortification of many nutrients including iron, nucleotides, fat formulations such as adding fatty acids like arachidonic acid (AA), docosahexenoic acid (DHA) and probiotics. However, no milk products were produced that are very similar to breast milk (Martin ***et al***, 2016). The aim of this study is to compare the biochemical compounds of some types of infant formula and to show how close they are to the breast milk.

MATERIALS AND METHODS

Samples collection

Infant formula milk

A survey was conducted of the types of infant milk products available in the drugstore, pharmacies and markets in Najaf Governorate. Despite the multiplicity of these formulas, 6 samples were selected based on the recommendation of pediatricians, which represent the best selling and consumption types, the 6 samples of infant milk formulas are 3 samples for the age group under 6 months and 3 samples representing the 6-month age group - the same year for the same manufacturers.The selected samples for the first age group were Bebelac 1, Similac 1 and Guigos 1, while the other age group was Bebelac 2, Similac 2 and Guigos 2. Different batches were taken with 3 replicates per batch to obtain a more representative sample. The samples were transferred to the laboratory after ensuring the safety of the containers from any damage or defects, either as a result of transport or storage and kept at the laboratory temperature until the laboratory tests.

Recovering Process

Recovering process was done according to the instructions and quantities shown on the plate of the formula packaging.

Breast Milk Samples

Total 240 samples of breast milk were collected from healthy mothers aged 18-30 during the period of breastfeeding (3-11) months of feeding. The samples were divided into 6 groups represented by age of the infant by 8 mothers for each of these age groups,where the distribution was divided into two age groups 3 ages below 6 months and 3 after 6 months. The ages were (3, 4, 5, 9, 10 and 11) months respectively. The volunteer mothers were selected periodically to measure the concentration of breast milk components of protein, fat, lactose, ash and moisture, after checking the healthy and nutritional status of mothers.These samples were collected between February 2018 and March 2019 from Al-Mashkhab district of Najaf Governorate, Iraq. The sample collection mechanism consisted of taking 20-30 ml of breast milk after training volunteers on how to sterilize the hand or milk pump prior to collection. The samples were then stored directly in sealed glass containers with complete information for each sample of the sample number, age of the baby, age of the mother and date of collection and freezing at 18°C in the freezer until testing.

Chemical tests for breast milk and formulas

IF Milk was recovered and then homogenized using glass hand-held homogenizer for 5 minutes per sample while the breast milk sample was only dissolved.After the preparation, the following tests were performed: moisture testing was conducted according to Russell and Gray (1979) method. Fat was determined using Gerber's method as mentioned by Ling (1963), ash according to the Ling method (1963) described by Ali (1989), while the protein was estimated by Biurat method (Luo ***et al***, 2018), and lactose was measured according to Itzhaki and Gill (1964).

RESULTS AND DISCUSSION

The first period of breastfeeding

Protein content

The results of breast milk samples were (1.431, 1.261, 1.284%) for month (3, 4, 5), respectively. While the protein content of the first-age formulas studied (1.18,1, 1.341, 1.182%) for the types (Bebelac 1, Similac 1 and Guigos1) respectively. In addition, results showed that the percentage of protein in the formula (Similac 1) was the best protein percentage between the studied formulas during the period of breast feeding target, the percentage of protein within this period was highest in breast milk (Fig. 1). These results were different for results obtained

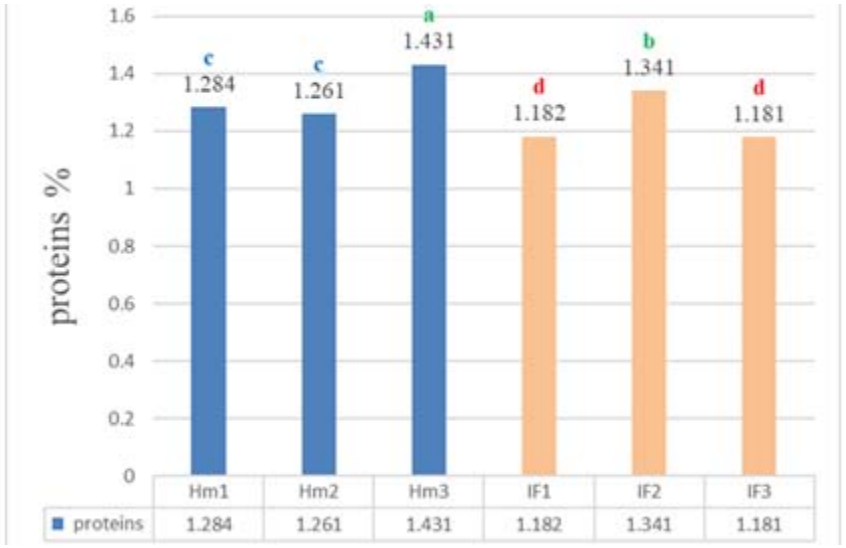

Fig. 1 : The effect of lactation periods on protein content in both breast milk and formula milk.

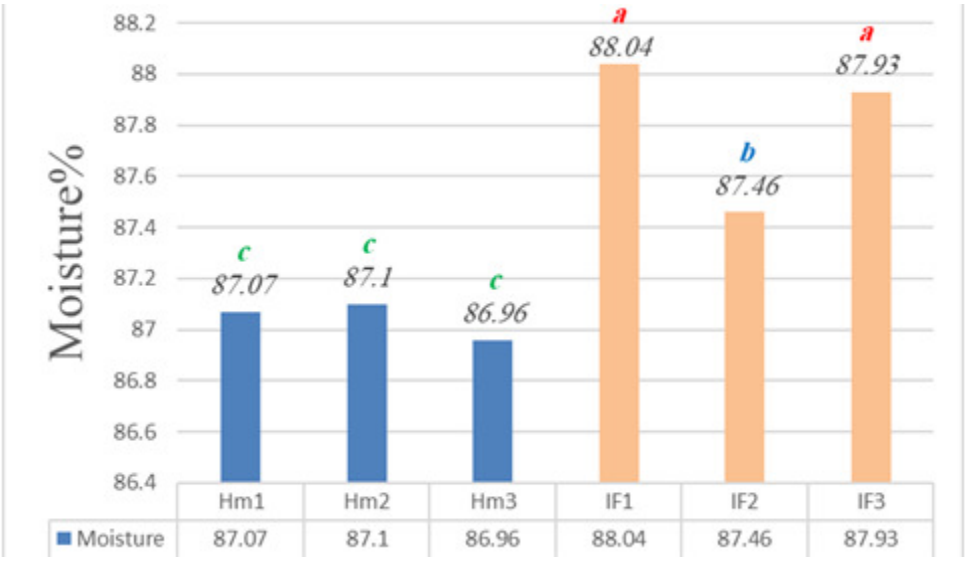

Fig. 2 : The effect of the period of breastfeeding on the moisture content in the breast milk and formula.

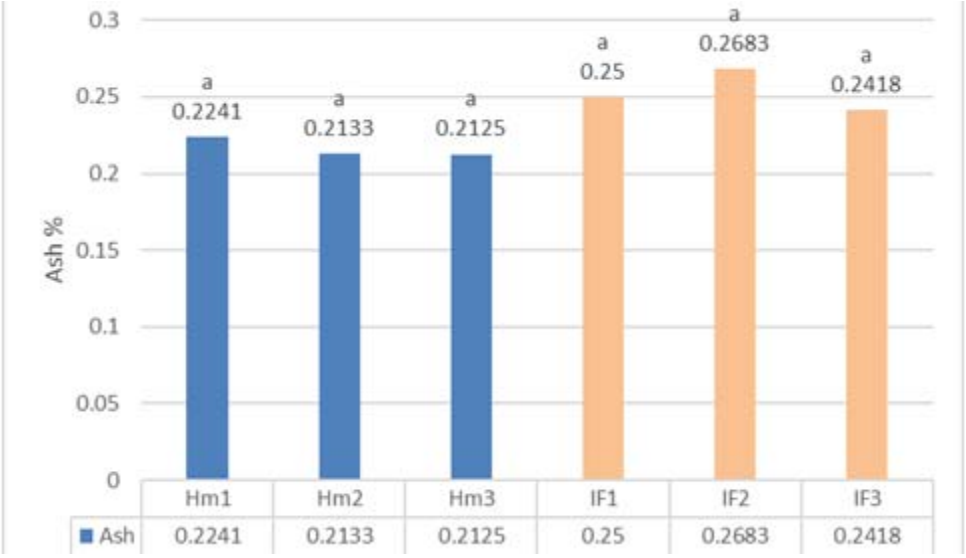

Fig. 3 : Effect of the period of breast feeding on the percentage of ash.

form WHO / FAO / UNU(2007); Hester ***et al*** (2012), EFSA (2013), EFSA (2014) and Zeo ***et al*** (2016).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac1 (IF4), Similac1 (IF5), Guigos1 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Moisture content

The results indicated that the moisture percentage in breast milk were (86.96, 87.1, 87.07%) in the month (3, 4, 5) respectively for the target lactation period, as for the first age group, the results showed that the moisture content after the recovery process, according to the instructions in the indication plate shown on the packaging of formulas was (87.93, 87.46, 88.04%) of the types (Bebelac 1, Similac 1 and Guigos1) respectively. Also, the results showed that the moisture content was highest in formula milk compared to breast milk for all breastfeeding times (Fig. 2). Milk formula (Bebelac 1), which contained the highest moisture content among all studied samples (88.04%), was an approach to Magi Zou (2016), Butts ***et al*** (2016) results.

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6)

Bebelac1 (IF4), Similac1 (IF5), Guigos1 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Ash Content

Fig. 3 shows that the percentage of ash in breast milk were (0.2125, 0.2133 and 0.2241%) for months (3.4.5), respectively, while the percentage of ash in infant formula for the first age group was (0.2418, 0.2683, 0.25%) for the types (Bebelac 1, Similac 1 and Guigos1), respectively. The results of the study of the milk samples did not indicate any significant differences between the ash percentages of the samples mentioned at the probability level ($p\leq0.05$). As in Fig. 3, although there are no significant differences, the highest percentage of ash in this period was formula (Similac 1) among the target samples during this period (0.2683%), which is similar to the result of George ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac1 (IF4), Similac1 (IF5), Guigos1 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$)

Fat content

In Fig. 4, the effect of breastfeeding period on the percentage of fat in both breast milk and formulas for the first age group showed that the results of the breast milk samples had a fat percentages of (4.46, 4.533, 4.5%) for month (3, 4, 5) respectively. As for the first age group, Fig. 4 indicated that the fat percentage was (3.533, 333, 3.467) of the types (Bebelac 1, Similac 1 and Guigos1) respectively. The highest fat percentage within this period for breast milk was in the fourth month (4.533%). As for the formulas, we found that the highest percentage of fat was in the milk formula (Similac 1), which amounted to (3.833%) andthis is similar to the achievement in the study of Abrahamse ***et al*** (2012), Lennox ***et al*** (2013), Giuffrida ***et al*** (2013), EFSA (2014), Martein (2016) and Butts ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac1 (IF4), Similac1 (IF5), Guigos1 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Lactose content

Fig. 5 shows the changes in lactose percentages for all the first age groups. The result showed thatthe breast milk samples had a lactose percentage of (6.933, 6.897, 6.927%) for month (3,4,5) respectively, while the results of the formula milk for the first age group was (7.093, 7.093, 7.057%) for the types (Bebelac 1, Similac 1 and Guigos1) respectively. In general, the results showed that the percentage of lactose in the formulas was the highest compared to the breast milk samples during the first period of breastfeeding. The highest percentage of lactose was recorded during the period for the milk of formulas of (Similac 1 and Guigos1) where it came equal (7.093%). These results were in agreement with the results reported by EFSA (2014), Zou (2016) and Butts ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac1 (IF4), Similac1 (IF5), Guigos1 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

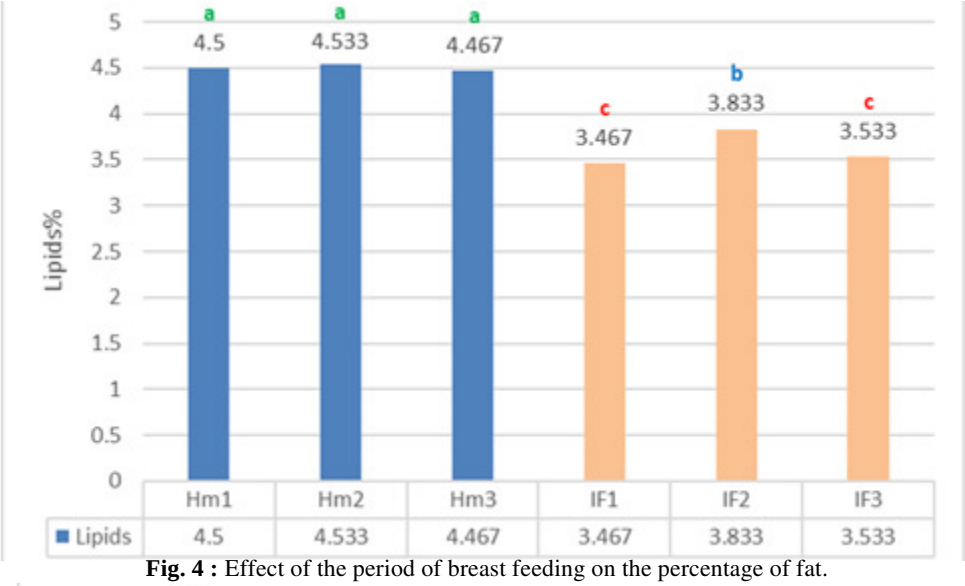

Fig. 4 : Effect of the period of breast feeding on the percentage of fat.

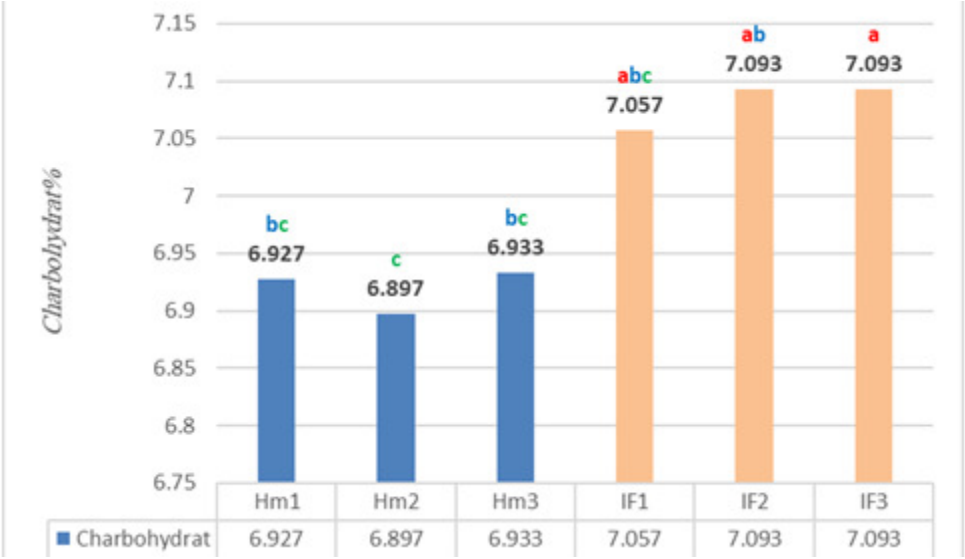

Fig. 5 : Effect of the period of breast feeding on the percentage of lactose.

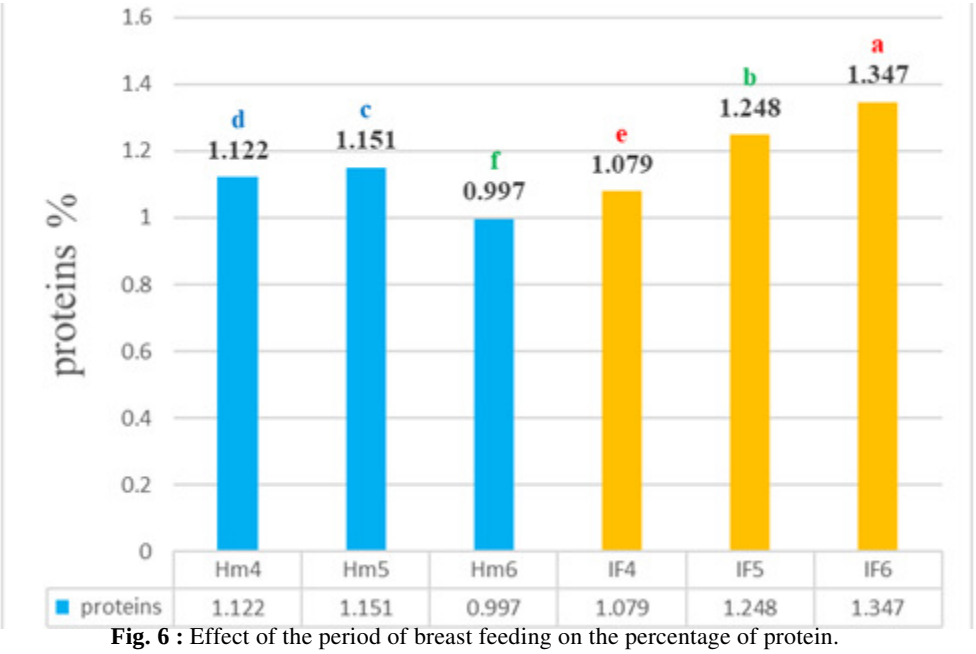

Fig. 6 : Effect of the period of breast feeding on the percentage of protein.

The second period of breastfeeding

Protein

Fig. 6 shows the effect of feeding periods on the percentage of protein in both breast milk and formula milk. The results of breast milk samples were (0.997, 1.151, 1.122) for the month (9, 10, 11) respectively, while the figure showed that the protein content of the second age group formulas studied was (1.181, 1.341, 1.82%) of the types (Bebelac 2, Similac 2 and Guigos2), respectively. Also, results showed that the percentage of protein in the product (Guigos2) was the best protein ratio between the studied formulas during the target period.In addition, we found that the average protein within this period is the highest for the formulas compared to the samples of breast milk.These results are similar to those of Hester ***et al*** (2012), EFSA (2013) and EFSA (2014) and contrary to Zeo ***et al*** (2016).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac2 (IF4), Similac2 (IF5), Guigos2 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Moisture content

Fi. 7 shows the effect of breastfeeding period on the moisture content in breast milk. The results indicated that the moisture percentage was (88.2, 87.95, 88.2%) for month (9, 10, 11), respectively for the target lactation period, while milk formulas for the second age group contained moisture after recovery (88.28, 87.81, 88.54%) for the types (Bebelac 2, Similac 2 and Guigos2) respectively with a slightly higher mean moisture than their breast milk samples. These results were in agreement with the results mentioned by Zou (2016), Martein (2016) and Butts ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac2 (IF4), Similac2 (IF5), Guigos2 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Ash content

Fig. 8 shows that the percentage of ash in breast milk was (0.2094, 0.287 and 0.2003%) for month (9.10.11), respectively while the percentage of ash in infant milk formulas for the second age group was higher than that of the samples of breast milk by (0.2483, 0.25, 0.2767%) for the types (Bebelac 2, Similac 2 and Guigos2), respectively. However, the studied results did not indicate any significant differences between the ash percentages of the samples mentioned above within the probability level ($p\leq 0.05$). In terms of the ratios shown, we found that the highest percentage of ash within the second period of the study was a milk formula (Bebelac 2) (0.2767%), where it is almost similar to what was reached by Butts ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac2 (IF4), Similac2 (IF5), Guigos2 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Fat content

Fig. 9 shows the studied results of breast milk samples within this age period. Breast milk samples contained fat (4.033, 4.067, 4.033%) for month (9, 10, 11), respectively, while the percentage in formulas for the second age group was (3, 3, 533, 3%) for the types (Bebelac 2, Similac 2 and Guigos2), respectively. From the above results, we found that the percentage of fat in breast milk samples during this period was higher than that of milk formulas. As for the highest percentage of fat for samples of breast milk was in the tenth month (4.066%).However, the results of this period were similar to those reported by Lennox ***et al*** (2013), Stam ***et al*** (2013), EFSA (2014), Martein (2016) and Butts ***et al*** (2018).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac2 (IF4), Similac2 (IF5), Guigos2 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

Lactose content

Fig. 10 shows changes in the percentage of lactose for both breast milk and formulas for the second age group, where the percentage of breast milk samples was (6.653, 627.6, 677%) for the month (9, 10, 11), respectively. While the results of the milk formula for the second age group indicated that the lactose percentages contained in the formulas were (7.126, 7.26, 7.107%) of the types (Bebelac 2, Similac 2 and Guigos2) respectively, so it is the highest in terms of lactose content.

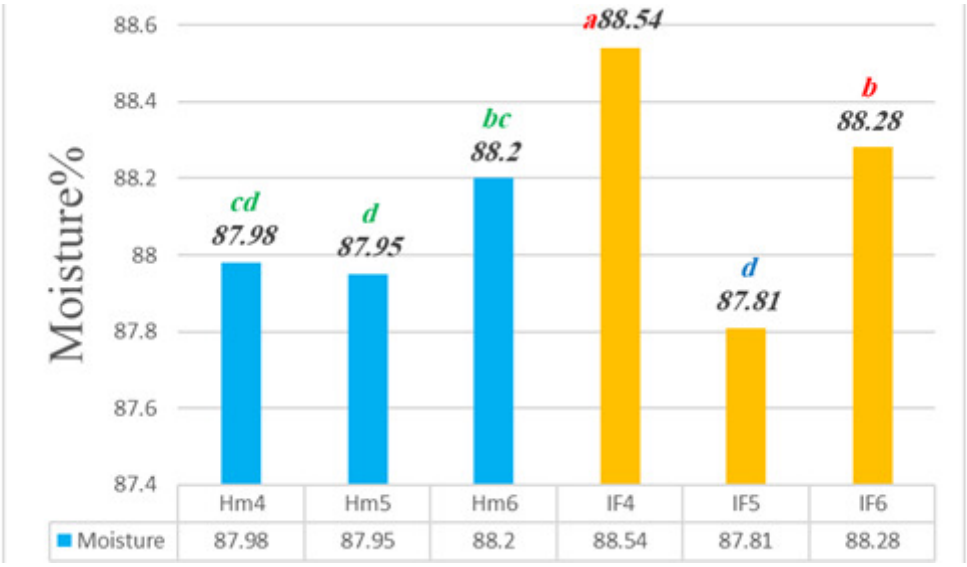

Fig. 7 : Effect of the period of breast feeding on the percentage of moisture.

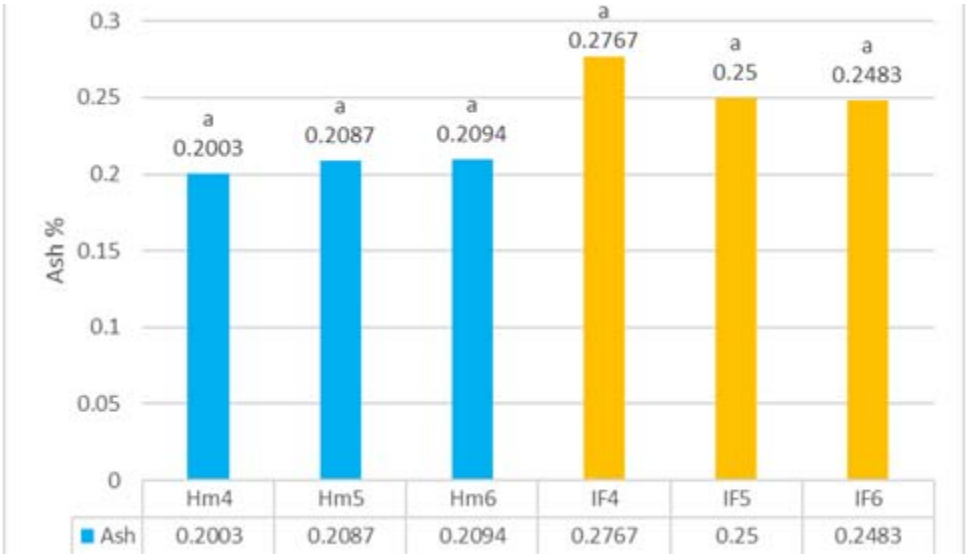

Fig. 8 : Effect of the period of breast feeding on the percentage of ash.

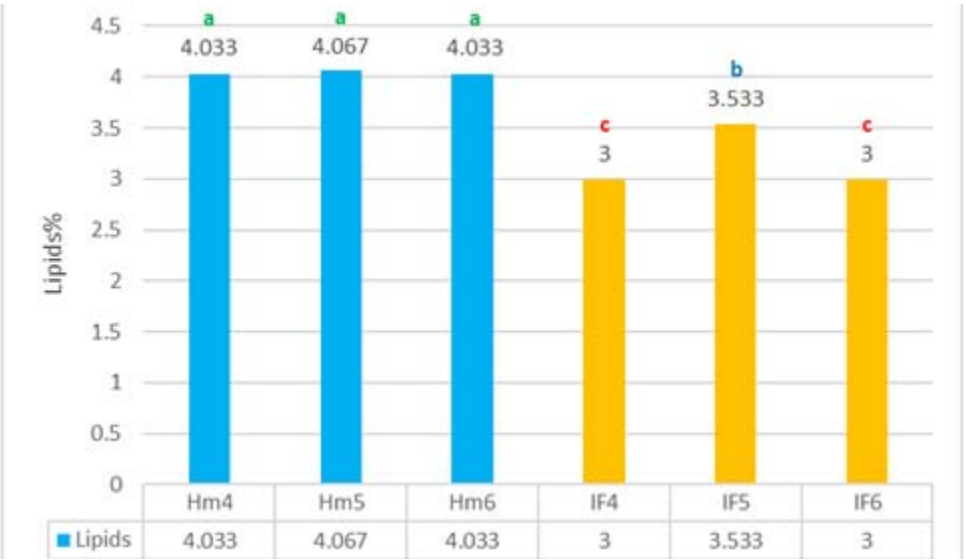

Fig. 9 : Effect of the period of breast feeding on the percentage of fat.

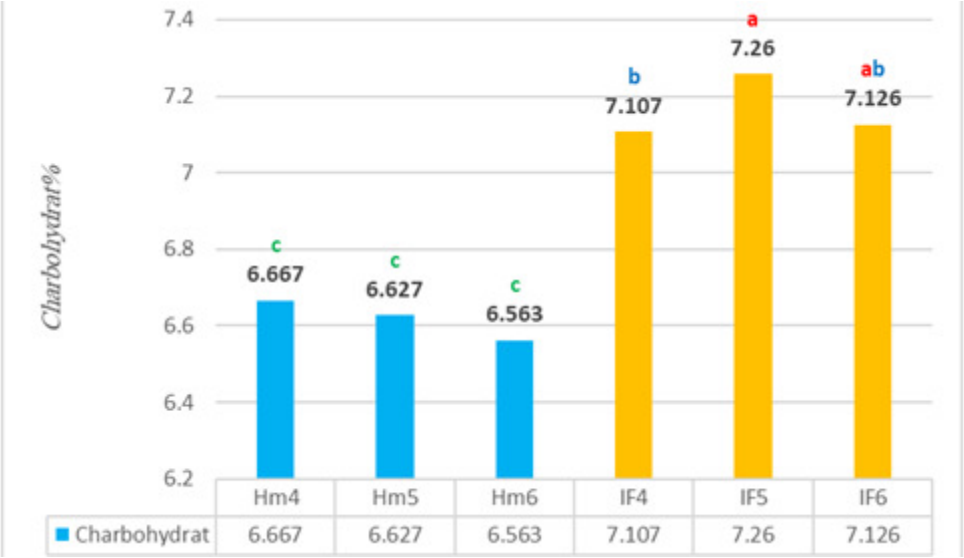

Fig. 10 : Effect of the period of breast feeding on the percentage of lactose.

The highest in terms of content of lactose is the (Similac 2) by (7.26%). These results were similar to that reported by Stam ***et al*** (2013), EFSA (2014) and George ***et al*** (2018) and contrary to Zou (2016).

Treatment (T), Time (Ti), breast milk for the ninth month (Hm4), breast milk for the ten month (Hm5), breast milk for the eleven month (Hm6))

Bebelac2 (IF4), Similac2 (IF5), Guigos2 (IF6)

Small letters that follow averages in a single column indicate significant differences within a probability level ($p< 0.05$).

CONCLUSION

The differences between breast milk and Infant formula at the two periods (less than six months and beyond), where infant milk formula contain protein and fat higher than breast milk in the first stage, while in the second stage, the fat percentage has decreased in the formula. The percentage of ash, moisture and lactosewas higher in infant formula than breast milk during the period of lactation.

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