Comparative Study of Thyroid Hormones and Thyroxin-Binding blobulin Camels Raised in The Central Region of Libya from Birth to A Full Year

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DOI: 10.21608/JALEXU.2024.314011.1219

Article Information

Received: August 20th 2024

Revised: September 9th 2024

Accepted: September 13th 2024

Published: September 30th 2024

ABSTRACT: This study was conducted in the central region of Libya to compare thyroid hormones and their binding proteins in three camels of Tunisian origin who were pregnant in the last month and were (6-8 years) old, and their calves from the moment of birth and for a period of one year. The overall mean of T_4, T_3, fT_4, and fT_3 for the calves was significantly ($P<0.05$) high. The concentrations of T_4, T_3, fT_4, and TBG at birth were significantly ($P<0.05$) high in calves. However, T_4 in summer was significantly ($P<0.05$) high in mothers. However, during the fall and winter, the level of T4 was significantly high ($P<0.05$) in calves. The T_3 concentration of calves increased significantly ($P<0.05$) during the spring, summer and autumn. The fT_4 concentration for the calves was significantly ($P<0.05$) higher during the summer, autumn and winter. Mothers' TBG was significantly ($P<0.05$) high during the fall and summer. T_4 increased significantly ($P<0.05$) in calves during month 1 and from months 5-12, while from months of 2-4 it increased significantly ($P<0.05$) in the mothers. T_3 concentration was generally higher in the calves than the mothers, and the significant increase ($P<0.05$) in calves was from 1-7 months. fT_4 in the calves was significantly ($P<0.05$) higher from 3-8 months. Calves' fT_3 was significantly high ($P<0.05$) from month 1-5 and from 8-10, while significant increase ($P<0.05$) was at month 9 in the mothers. TBG in the calves was significantly ($P<0.05$) high during the month 1, while in the mothers, it was highly significant ($P<0.05$) in the months 5, 6, 8, and 11.

Keywords: Camel, Months, Seasons, Thyroid hormones, Thyroxin-binding globulin.

INTRODUCTION

The single-humped camel (*Camelus dromedarius*) can survive in harsh environmental conditions and plays a vital role in covering the needs of pastoral peoples in arid and semi-arid regions by using them in agricultural work and providing products such as milk, meat and animal hair. Camels, the ship of the desert, are among the most adapted animals to live in deserts. Camels are ruminants that adapt to hot, dry and windy climates. The camel differs other animals that live temperature climates by the ability to lose 25% of its body weight without abnormalities in body functions and it can concentrate its urine. The body temperature of a camel varies widely. The internal stability of the camel's body depends on the endocrine system in hot weather (Sharma, et al., 2013) and (Atoji, Yamamoto, Suzuki, & Sayed, 1999). This adaptation depends on changes in the activity of some endocrine glands, such as the thyroid gland, which contribute too many important functions. Thyroid hormones are central regulators of energy metabolism (Tajik, Sazmand, Hekmatimoghaddam, & Rasooli, 2013). These hormones are the primary stimuli for the endocrine glands to generate heat for adaptation, and thus regulate body temperature. Thyroid gland is an endocrine gland with the unique feature of being able to concentrate a large amount of iodine for the synthesis of thyroxin and triiodothyronine (Banks, 1993). Camel's thyroid gland consists of small follicles lined with cuboidal epithelium and is elongated when the cells are active. While large follicles in camels contain low cuboidal epithelium, some very large follicles may have squamous epithelium, which indicates that these cells are active (Bello, et al., 2015). Some researchers as (Kausar & Shahid, 2006) stated that the follicles are filled with a slimy, jelly-like substance. The thyroid hormones, triiodothyronine (T_3) and thyroxin (T_4), are involved in the growth, maturation, and cellular metabolism of animals (Aziz, Patil, & Thakur, 2014) (Duru, Devrim, Macun, Duru, & Şenol, 2021). The presence of positive correlations between T_3 and T_4 concentrations confirms that T_3 is the most metabolically active iodothyronine (Tata, 2011), especially during normal growth and development, demonstrating its pivotal role in regulating growth and energy metabolism (Yavuz, del Prado, & Celi, 2019). Thyroid hormones influence lipid metabolism by increasing lipolysis in adipose tissue and stimulating lipogenesis by increasing the activity of certain enzymes (Eshratkhah,

Sadaghian, & Eshratkhah, 2009). Hormonal changes during the perinatal period, an optimal concentration of hormones is necessary to maintain the health of the mother, fetus, and calf, to repeat birth without complications, to initiate lactation, and to prepare the mother's body for a new pregnancy (Wankhade, et al., 2017) and (Mikuła, Pruszyńska-Oszmałek, Maćkowiak, & Nowak, 2018) in cows, (Kurpinska, Jarosz, & Skrzypczak, 2019), and (Lucy, 2019) in cow. Seasonal changes have an effect on the concentration of thyroid hormones in the serum of some domestic animals (Prakash & Rathore, 1991) and (Yagil, Etzion, & Ganani, 1978). Thyroid gland in most ruminants consists of two lobes connected by a bridge of tissue called the parathyroid glands. The thyroid gland is well endowed with the highest rates of blood flow per gram of tissue compared to any other organ in the body (Ganong, 1985). A major external regulator of thyroid activity is environmental temperature. During heat stress, blood T_3 and T_4 concentrations decrease, as do feed intake, feed intake, growth, and milk production (Marai & Haeeb, 2010) and (Zhang, et al., 2014). The seasonal level of thyroid hormone levels in the blood often showed a maximum value during winter and a minimum during summer (Mayahi, Mamouei, Tabatabaei, & Mirzadeh, 2014). The seasonal variation effect on the concentration of thyroid hormones in the blood plasma of camels (Tajik, Sazmand, Hekmatimoghaddam, & Rasooli, 2013). Thyroid hormones are essential for fetal brain development, as well as for many aspects of pregnancy and fetal development. Thyroxin is essential for the proper metabolism of the body and plays an important role in the development and differentiation of all cells of the body (Choksi NY, 2003). To date, many morphological differences of this gland remain undiscovered. Moreover, compared to studies on other domestic animals such as cattle, sheep, and goats, the literature on physiological and hormonal changes during pregnancy in camels is sparse, as camels have a long gestation period (~13 months) and are expected to require energy. Rapid flow during pregnancy, this may affect the levels of some biochemical indicators. Changes may occur in the biochemical parameters of the blood during different seasons of the year, which may have the main effect in controlling the various activities of the animal body with less physiological efforts within the so-called neutral zone of the current environmental conditions (Badawy, Gawish, Khalifa, El-Nouty, & Hassan, 2008). There are many physiological indicators that are important and reliable for stress assessment, including (thyroid hormones) in camels in particular (El Khasmi, et al., 2015) and (Lemrhamed, et al., 2018). Due to the lack of research on thyroid hormones and tracking their levels from the moment of birth and for a full year, as well as the on changes that occur at the moment of birth for each of the mothers or calves, and also the follow-up of the animal during a year and in its natural pasture. Therefore, the aim of the study was to estimate the effect of birth, months, and seasons of the year on thyroid hormones and the thyroxin-binding globulin (TBG).

MATERIALS AND METHOD.

Three pregnant camels in the last month and the ages of (6-8 years), were chosen. The pasture was in the central region of Libya. Climatic information (average, maximum and minimum temperatures and humidity) during the past ten years was collected from the Meteorological Authority. The average annual air temperature is 22˚C, while the humidity ranges between 20-50%, and since drought dominates the region, the air temperature in the summer months reaches around 42˚C about humidity 15-20 %. About 2 ml of blood were drawn through the jugular vein of the mothers and calves immediately after birth, then every month during a year, with place the blood directly into plastic tubes that do not contain anticoagulant (serum) and store it at low temperatures until arriving to the laboratory..

The method of radioimmunoassay (RIA) was used by Kit, by (Boehringer Mannheim) and the device name 300 Es was used to measure the concentrations each of thyroxin (T_4), and triiodothyronine (T_3). While the concentrations of thyroxin-binding globulin (TBG), free thyroxin (fT_4), and free triiodothyronine (fT_3) were measured by the enzymatic immunoassay (ELISA) method, a kit was used by (Boehringer Mannheim) For the 300 Es.

Statistical analysis

The data of the study were analyzed statistically using the statistical package (SPSS., 2016), and to find out the differences between the averages, the LSD test was used.

RESULTS AND DISCUSSION.

Overall average

Table (1) show a significant increase ($P<0.05$) for each of T_4, T_3, fT_4 and fT_3 for the calves, compared to the mothers. This may be due to the transferring of hormones into the blood of fetuses from mothers, as a gradual rise of these hormones were observed in the last stages of pregnancy (Hozifa, Shadia, & Shamseldein, 2017), reaching its highest value at birth as noted by (Cernescu, et al., 2010) in cows. It may also be due to the growth and activity of calves in the pasture (Magdub, Salem, Abubaker, & Al-rock, 2005). The average concentration of T_4 during the period from birth to the age of one year was 196.5 nmol / L, and this value was lower than that was found by (Wasfi, Hafez, El-Taybe, & Eltaher, 1987) and

higher than what was found by (Hozifa, Shadia, & Shamseldein, 2017); (Javad, Alireza, moghaddam, & Aria, 2013) and (Magdub, Zaeid, Shareha, Abobaker, & Kraiw, 1986). The average T_3 concentration in this study was about 1.91 nmol/L, which is a lower in value than that was found by (Wasfi, Hafez, El-Taybe, & Eltaher, 1987) and (Hozifa, Shadia, & Shamseldein, 2017), and higher than that what found by (Nazifi, Mansourian, Nikahval, & Razavi., 2008), (Magdub, Zaeid, Shareha, Abobaker, & Kraiw, 1986), this may be due to the condition of the animal, age, type, and the environmental conditions. The overall mean concentration of TBG was 32.9 nmol/L, and there were no significant differences between mothers and calves.

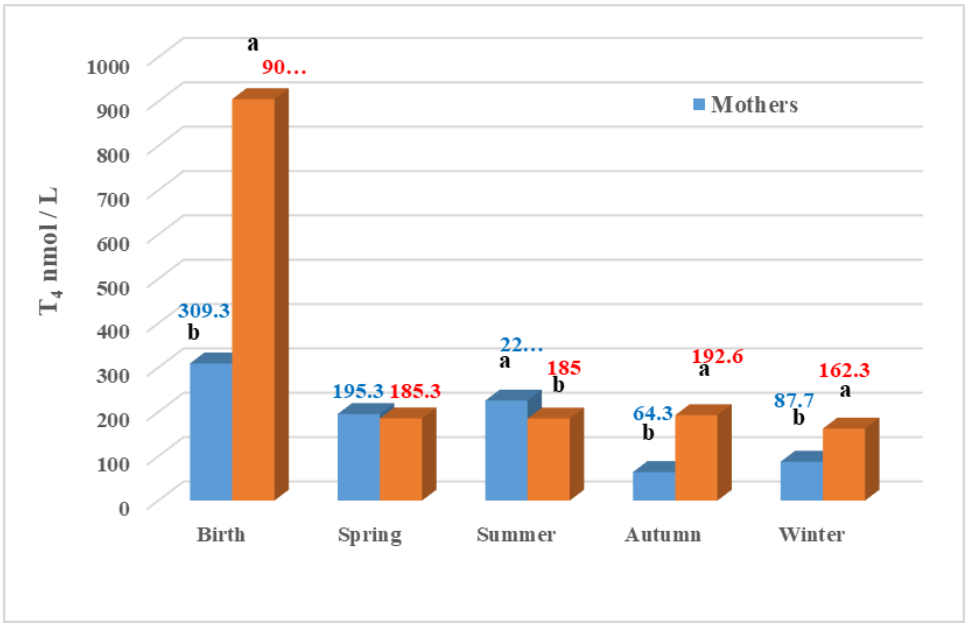
(Table.1) Concentration of thyroid hormones and thyroxin-binding globulin. (± standard error/a, b significant)

Parameter	Mothers	Calves	Average during one year
T_4 nmol / L	$156^b \pm 17.14$	$237^a \pm 27.83$	196.5 ± 17.94
T_3 nmol / L	$1.21^b \pm 0.120$	$2.62^a \pm 0.225$	1.91 ± 0.156
fT_4 nmol / L	$0.011^b \pm 0.00044$	$0.021^a \pm 0.00075$	0.061 ± 0.00071
fT_3 pmol / L	$0.0066^b \pm 0.00088$	$0.0095^a \pm 0.00049$	0.008 ± 0.00049
TBG nmol / L	33.8 ± 2.194	32.0 ± 0.28	32.9 ± 1.435

Effect of seasons on thyroid hormones and thyroxin-binding globulin (TBG).

A- The effect of seasons on thyroxin.

The T_4 levels in calves، blood at birth in (Fig. 1) were significantly ($P<0.05$) higher than in the mothers. This may be due to the activity of the thyroid gland in secreting its hormones at the seventh week of pregnancy (El-Shiekh, Rasheed, & Amin, 1966). Then, this may be due to the transferring of the hormones into the blood of fetuses from the mothers (Hozifa, Shadia, & Shamseldein, 2017). On the other hand, because of positive association of parathyroid hormones with growth in buffaloes (Ingole, Deshmukh, Nagvekar, & Bharucha, 2012). In addition, the decrease in thyroid hormones in mothers during pregnancy may be due to an increased conversion rate or decreased secretion of hormones from the thyroid gland (Arash, Zhila, Mohammad, & Hossein, 2014). The level of the hormone increased significantly ($P<0.05$) at birth over the seasons of the year, it may be due to pregnancy in cattle (Hozifa, Shadia, & Shamseldein, 2017), (Fiore, et al., 2015). During the spring, there were no significant differences between the mothers and in the calves. The T_4 in the blood of mothers during the summer and spring was higher than the rest of the seasons, because camels have the ability to raise their body temperature, which allows them to survive in hot environments. In summer, T_4 was significantly ($P<0.05$) higher in mothers than calves, and in spring, there was no significant increase. This increase in the two seasons may be due to milk production as in cows, as indicated by (Özkan, Alparslan, Hasan, Sibel, & Ali, 2021). In addition, the rise in the level of the hormone in this study during the summer does not agree with what was mentioned by (Hozifa, Shadia, & Shamseldein, 2017) and (Rita, et al., 2016). This difference may be due to the availability of water in the summer, and the hormone level rises, as was reported (Yagil, Etzion, & Ganani, 1978). During the autumn and winter seasons, the level of T_4 was significantly ($P<0.05$) higher in the blood of the calves than that of the mothers, and this may be due to the effect of sex (Mahe, Oladele, & Adamu., 2022) and (Elrayah, Hussein, Sheikh, Osman, & Mahadi, 2009), or sex and pasture activity (Magdub, Salem, Abubaker, & Al-rock, 2005). In fact, T_4 concentrations are considered as an indicator of energy balance, body weight gain, and protein deposition (Medica, Cravana, Ferlazzo, & Fazio., 2020). The higher values of T_4 and T_3 were observed in the winter may be due to thermoregulation. By increasing the internal production of heat (Todini, 2007). In addition, it is clear from these results that there is a direct relationship between the concentration of TBG and the T_4 concentration, and this confirms that the rise in thyroxin concentration in camels may be due to the increase in the concentration of TBG (Magdub, Salem, Abubaker, & Al-rock, 2005).

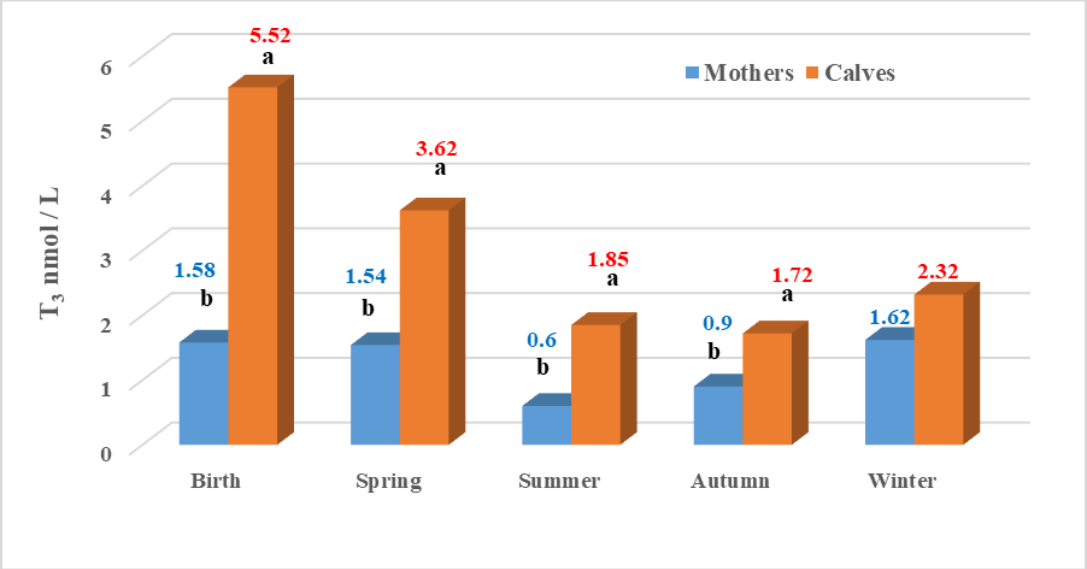


(Fig. 1) The effect of seasons on thyroxin T_4 in the blood of the mothers and the calves from birth to one year of age. (a, b significant in birth and season).

B- Triiodothyronine.

The concentration of T_3 for the calves showed a significant ($P<0.05$) higher than the mothers at birth, and during the spring, summer and autumn seasons, while in the winter it was non-significant (fig. 2). At birth in the calves, the hormone is significantly ($P<0.05$) higher, it may be due to the transferring of the hormones during the last stages of pregnancy (Hozifa, Shadia, & Shamseldein, 2017), as for the seasons of the year, it may be due to growth as in buffaloes (Ingole, Deshmukh, Nagvekar, & Bharucha, 2012), or it may be due to the effect of sex (Mahe, Oladele, & Adamu., 2022). The rise of the hormone in the two animals during winter corresponds (Rita, et al., 2016) and is not significant between them compared to summer and autumn, and is estimated to be due to metabolic activity (Todini, 2007).

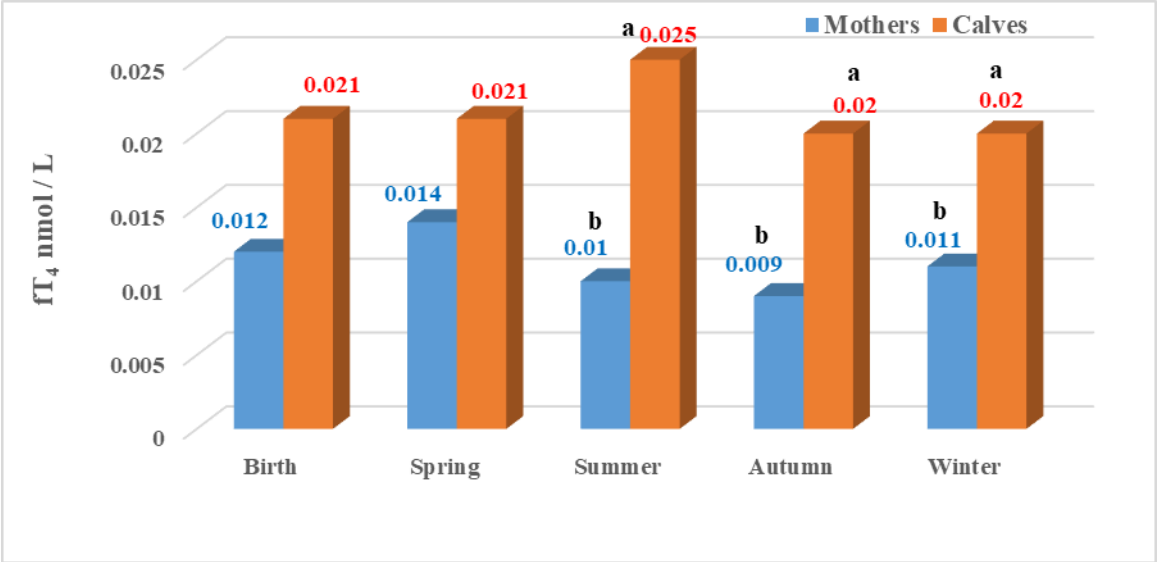
T_4 and T_3 changes are different during the growth period, with a positive correlation between total iodothyronine in developing calves, confirming this previously described relationship in both buffaloes and goats at different ages (Bhooshan, 2010). On this basis, T_3 and T_4 concentrations appear to be more susceptible to changes attributable to several external influences, which are usually associated with the growth of calves as indicated in beef calves (Medica, Cravana, Ferlazzo, & Fazio., 2020). Both T_3 and T_4 may contribute to homeostasis during the anabolic processes of the body, thus endocrine alterations may be physiological responses to growth (Medica, Cravana, Ferlazzo, & Fazio., 2020).



(Fig. 2) The effect of seasons on T_3 in the blood of the mothers and the calves from birth to one year of age. (a, b significant in birth and season).

C-free thyroxin fT4.

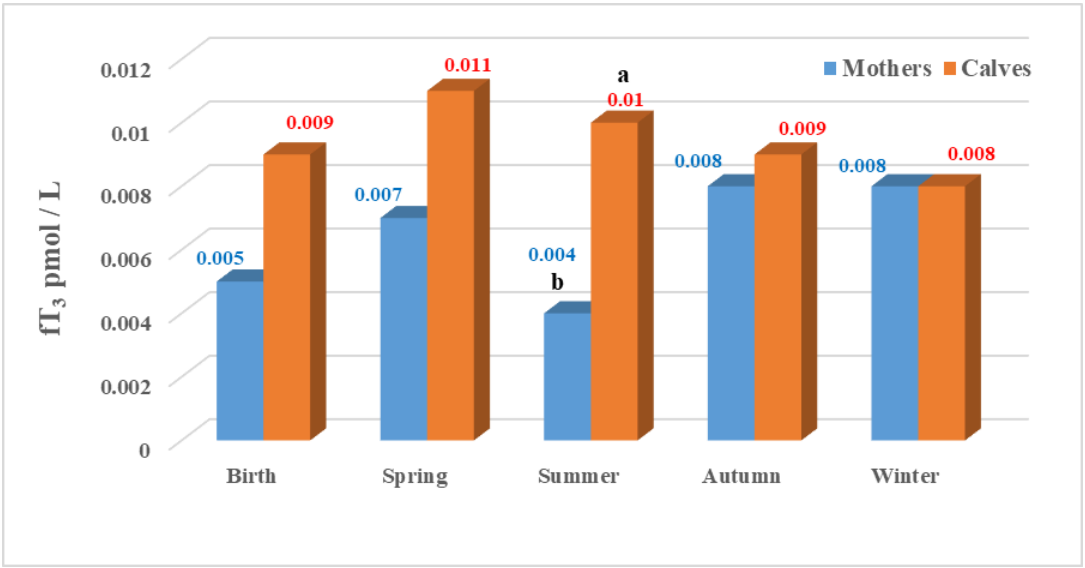
Calves fT_4 was significantly ($P<0.05$) higher than the mothers and during the seasons of the year except at birth and in the spring, it was high without significance. This height may be due to the effect of sex (Omidi, Sajedi, & Montazer, 2014). At birth, the rise in the hormone in the calves may be because of an increase in the level of TBG during the last stages of pregnancy. The rise of fT_4 during the spring and summer seasons agrees with what was mentioned (Magdub, Salem, Abubaker, & Al-rock, 2005). When comparing and following up the changes in the concentration of TBG with the concentration of fT_4, it was noticed that there was an inverse relationship between them, and this confirms that the high level of thyroxin in camels is present in a linked form with TBG (Magdub, Salem, Abubaker, & Al-rock, 2005).



(Fig. 3) Effect of seasons on free thyroxin (fT_4) in the blood of the mothers and the calves from birth to one year of age. (a, b significant in birth and season).

D-free triiodothyronine.

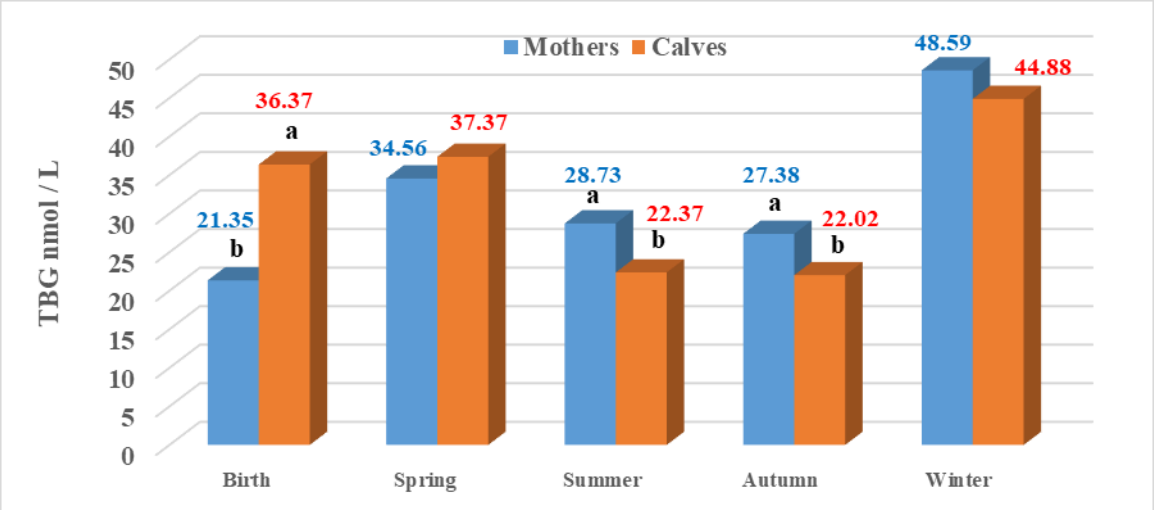
The level of fT_3 in (Fig. 4) was higher in the calves than the mothers without significance at birth and throughout the year except for summer. The rise in the hormone at birth may be due to the transferring of thyroid hormones from the mother in the last stage of pregnancy (Hozifa, Shadia, & Shamseldein, 2017), as mentioned above. The increase in fT_3 levels in the seasons may be due to sex (Omidi, Sajedi, & Montazer, 2014) or to sex and development (Magdub, Salem, Abubaker, & Al-rock, 2005). This hormone in the calves significant ($P<0.05$) increase in the summer season may be due to the increase in the rise of the thyroid hormones (Magdub, Salem, Abubaker, & Al-rock, 2005).



(**Fig. 4**) Effect of seasons on free triiodothyronine **fT_3** in the blood of the mothers and the calves from birth to one year of age. (**a**, **b** significant in birth and season).

E - Thyroxin binding globulin.

(Fig. 5) At birth, the concentration of TBG in the blood serum of the calves was significantly higher (P<0.05) than the mothers, and it may be due to a decrease in thyroid hormones in the mothers as written by (Abd-El-Rahman, Ibrahim, & Elmetwaly., 2017) and (Hozifa, Shadia, & Shamseldein, 2017) and (Omidi, Sajedi, & Montazer, 2014). In the spring season, TBG of the calves was high and at the same level at birth, but was not significant compared to that of the mothers. However, the concentration of TBG in mothers blood was significantly (P<0.05) higher than it had at birth, and this agrees with (Abd-El-Rahman, Ibrahim, & Elmetwaly., 2017) and (Omidi, Sajedi, & Montazer, 2014) when they measured the total protein. While during the autumn and summer seasons, the level of TBG in the blood of the mothers was significantly (P<0.05) higher than that of the calves, while in winter it was significantly higher in the mothers than the calves. In addition, the level of TBG in winter is significantly (P<0.05) higher than the rest of the seasons and birth, It may be due to no need of energy, or to the availability of water, or to the lower temperature.

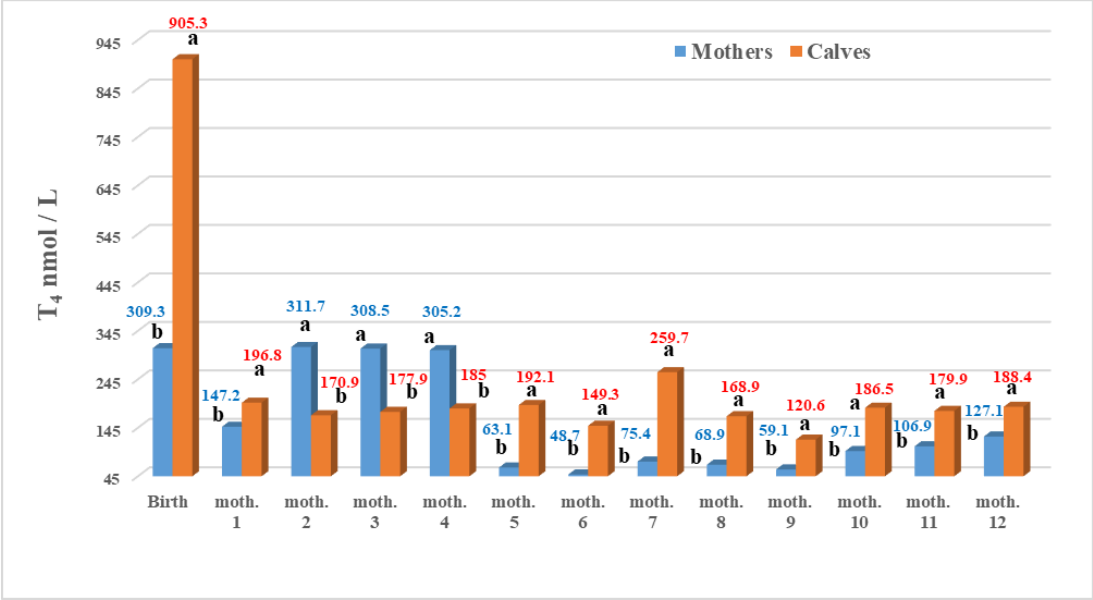


(**Fig. 5**) The effect of seasons on the thyroxin-binding globulin **TBG** in the blood of the mothers and the calves from birth to one year of age. (**a**, **b** significant in birth and season).

Effect of months of the year on thyroid hormones and thyroxin-binding globulin.

1- Thyroxin.

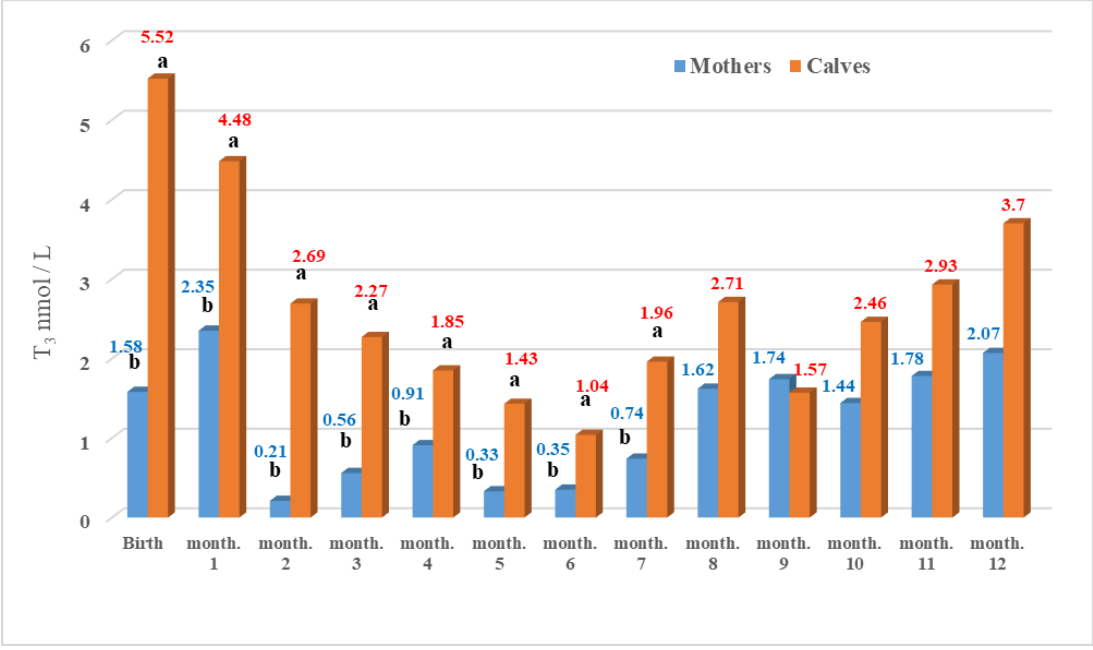
The concentration of T_4 shown in figure (6) was the highest possible at the birth compared to the rest of the months, and it was significantly higher (P<0.05) in the calves than in the mothers due to the activity of the thyroid gland in secreting its hormones at the seventh week of pregnancy (El-Shiekh, Rasheed, & Amin, 1966). And then, as mentioned above, it may be the transmission of hormones from the mothers (Hozifa, Shadia, & Shamseldein, 2017), or may be to the decrease in thyroid hormones of the mothers during pregnancy, or may be due to an increase in the conversion rate, or to decrease in gland secretion (Arash, Zhila, Mohammad, & Hossein, 2014), or for the high concentration of TBG in the mothers. In addition, it decreased during the first month, according to that was mentioned by (Agarwal, Rai, & Khanna., 1992), but with a significant (P<0.05) increase to its level in the calves than the mothers. T_4 increased significantly (P < 0.05) in the blood of the mothers for the calves from the second to the fourth months, in agreement of (Agarwal, Rai, & Khanna., 1992) and may be due to milk production as in cows (Özkan, Alparslan, Hasan, Sibel, & Ali, 2021). After that, the concentration of T_4 increased significantly (P<0.05) in the calves than the mothers from the fifth month to the end of the study, may be due to the effect sex (Mahe, Oladele, & Adamu., 2022) and (Elrayah, Hussein, Sheikh, Osman, & Mahadi, 2009) or sex and calves activity in the pasture (Magdub, Salem, Abubaker, & Al-rock, 2005). During the seventh month, the level of concentration T_4 was higher than in the other months, and this may be due to the high temperature and the availability of water (Yagil, Etzion, & Ganani, 1978).



(Fig. 6) Effect of the months on thyroxin T_4 in the blood of the mothers and the calves from birth to one year of age. (a, b significant in birth and month).

2- Triiodothyronine.

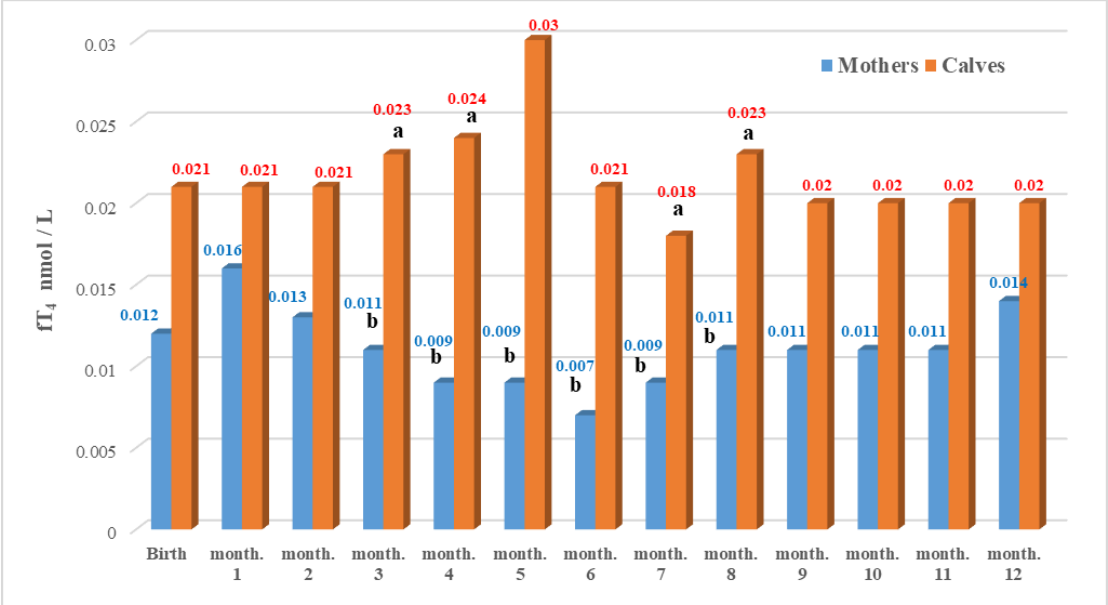
The concentration of T_3 (Fig. 7) was generally higher in the calves than in the mothers, and the significant ($P<0.05$) increase in calves was from birth to the seventh month. At birth, as mentioned above, it may be the transfer of hormones from the mothers (Hozifa, Shadia, & Shamseldein, 2017), or it may be the effect of sex (Mahe, Oladele, & Adamu., 2022). After birth, it gradually decreased to the sixth month. A mother in a month has a decrease in the hormone after birth, may be due to the effect of cows lactation (Özkan, Alparslan, Hasan, Sibel, & Ali, 2021). The level of T_3 in calves and mothers increased non-significantly from the eighth month to the end of the study. This change was associated with changes in the concentration of both TBG and T_4, which indicates that the majority of thyroid hormones are present in protein-bound form in camel's blood (Magdub, Salem, Abubaker, & Al-rock, 2005).



(Fig. 7) Effect of months on triiodothyronine T_3 in the blood of the mothers and the calves from birth to one year of age. (a, b significant in birth and month).

3-Free thyroxin.

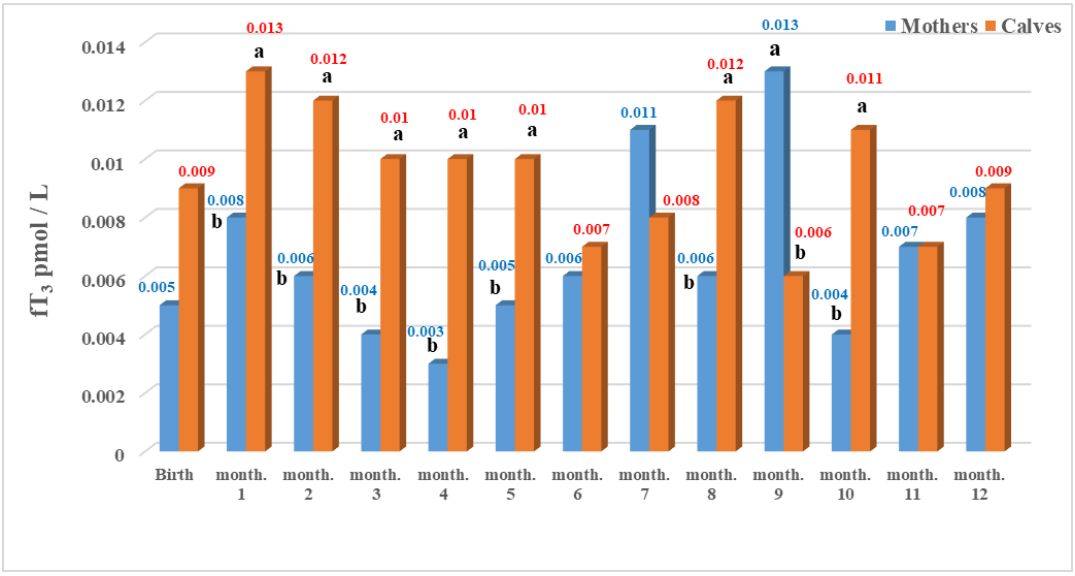
The concentration of fT_4 (Fig. 8) in the calves was higher than that of the mothers from birth to the end of the study, and the significant ($P<0.05$) increased during the third to the eighth month, which could be attributed to may be due to growth and sex (Magdub, Salem, Abubaker, & Al-rock, 2005). The gradual decrease of fT_4 in mothers may be due to milk production in cows (Özkan, Alparslan, Hasan, Sibel, & Ali, 2021) and (Kurpinska, Jarosz, & Skrzypczak, 2019). The concentration then stabilized from the ninth month to the end of the experiment.



(**Fig. 8**) The effect of the months on free thyroxin **fT_4** in the blood of mothers and calves from birth to one year of age. (**a**, **b** significant in birth and month).

4- Free triiodothyronine.

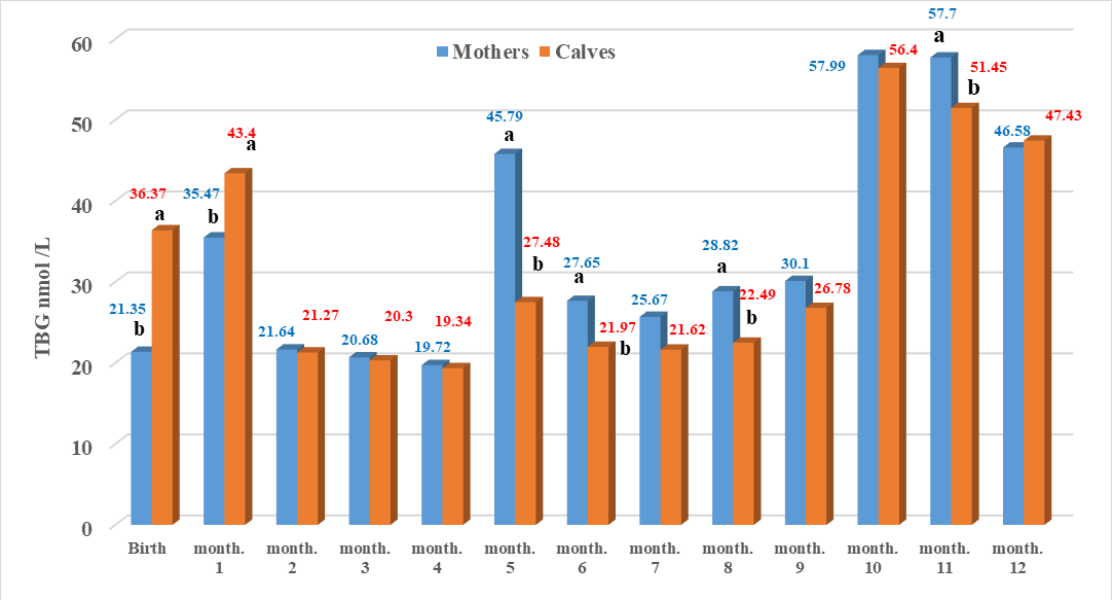
The concentration of free fT_3 (Fig. 9) from birth to the fifth month was significantly ($P < 0.05$) higher in the calves than the mothers, and it may be caused by the transfer of hormones from the mothers (Hozifa, Shadia, & Shamseldein, 2017), or it may be the effect of sex (Mahe, Oladele, & Adamu., 2022), and (Magdub, Salem, Abubaker, & Al-rock, 2005). The mothers' fT_3 level in the first month nonsignificant increased from birth, then gradually decreased due to the association of thyroid hormones with milk production (Magdub, Salem, Abubaker, & Al-rock, 2005). During the eighth and tenth months, fT_3 level of the calves was significantly high ($P<0.05$), while in the ninth month, the value was significant ($P<0.05$) for the mothers.



(**Fig. 9**) Effect of months on free tri-threonine **fT_3** in the blood of the mothers and the calves from birth to one year of age. (**a**, **b** significant in birth and month).

5- Thyroxin Binding Globulin.

The level of TBG in (Fig. 10) significantly (P<0.05) high in the calves during birth and the first month, and it may be due to the positive correlation with thyroxin concentration (Magdub, Salem, Abubaker, & Al-rock, 2005). During the months from the second to the fourth month, it decreased gradually and there were no significant differences between the two animals, and this was explained by growth and milk production (Magdub, Salem, Abubaker, & Al-rock, 2005). TBG increased in the mothers than the calves from the fifth to the eleventh month. TBG of the mothers in the fifth month was significantly (P<0.05) higher than that of the calves. The concentration of this protein decreased in the two animals from the sixth to the ninth month with its increase in the mothers, and it was not significant (P<0.05) for the mothers except in the sixth to the eighth months. Then, TBG significantly (P<0.05) increased for the two animals during the remaining months, and it was significantly (P<0.05) elevated for the mothers during the eleventh month. The consistency of the level of TBG between mothers and calves after the sixth month may indicate that young camels adapted to the environment after the fifth month of their life.



(**Fig. 10**) The effect of the months on the thyroxin-binding globulin **TBG** in the blood of the mothers and the calves from birth to one year of age. (**a**, **b** significant in birth and month).

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الملخص العربي

دراسة مقارنة لهرمونات الدرقية والبروتين الرابط لها للإبل الليبية في المرعى من الولادة لسنة كاملة

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المستخلص:

أجريت هذه الدراسة في المنطقة الوسطى من ليبيا لمقارنة هرمونات الغدة الدرقية والبروتينات الرابطة لها في ثلاث جمال من أصل تونسي كانت حامل في الشهر الماضي وأعمارها (6-8 سنوات) وعجولها منذ لحظة الولادة ولمدة سنة واحدة. وكان المتوسط العام لـ T_4، T_3، fT_4، وfT_3 للعجول مرتفعاً معنوياً ($P<0.05$). كانت تراكيز T_4، T_3، fT_4، وTBG عند الولادة مرتفعة بشكل معنوي ($P<0.05$) في العجول. ومع ذلك، كان T_4 في الصيف مرتفعاً بشكل ملحوظ ($P<0.05$) لدى الأمهات. ومع ذلك، خلال فصلي الخريف والشتاء، كان مستوى T_4 مرتفعاً بشكل معنوي ($P<0.05$) في العجول. ارتفع تركيز T3 للعجول معنويا ($P<0.05$) خلال الربيع والصيف والخريف. وكان تركيز fT_4 للعجول أعلى معنويا ($P<0.05$) خلال فصل الصيف والخريف والشتاء. كان TBG للأمهات مرتفعًا بشكل ملحوظ ($P<0.05$) خلال فصلي الخريف والصيف. ارتفع T_4 معنويا ($P<0.05$) في العجول خلال الشهر الأول ومن الأشهر 5-12، بينما من الأشهر 2-4 ارتفع معنويا ($0.05>P$) في الأمهات. وكان تركيز T3 أعلى بشكل عام في العجول منه في الأمهات، وكانت الزيادة المعنوية ($0.05>P$) في العجول خلال الفترة من 1-7 أشهر. كان fT_4 في العجول أعلى معنوياً ($P<0.05$) من 3-8 أشهر. كان fT_3 للعجول مرتفعاً معنوياً ($P<0.05$) من الشهر 1-5 ومن 8-10، بينما كان الارتفاع المعنوي ($P<0.05$) عند الشهر التاسع في الأمهات. كان TBG في العجول مرتفعاً معنوياً ($P<0.05$) خلال الشهر الأول، بينما في الأمهات كان عالياً ($P<0.05$) في الأشهر 5، 6، 8، و11.

الكلمات المفتاحية: الإبل، الأشهر، الفصول، هرمونات الغدة الدرقية، الجلوبيولين المرتبط بهرمون الغدة الدرقية.