***Original Article***

**Chemical composition of colostrum from Azawak cow in Niger compared with meta-analytical data.**

H Abdou1\*, H Marichatou1, J-F Beckers2, I Dufrasne2 and J-L Hornick2

1\*Faculty of Agriculture, University Abdou Moumouni of Niamey, Niamey, Niger.

2Faculty of Veterinary, University of Liege, Liege, Belgium.

Correspondence to: H Abdou, Faculty of Agriculture, University Abdou Moumouni of Niamey, Niamey, Niger. E-mail: hanafiou82@yahoo.fr

**Abstract:**

This study aimed at comparing data obtained from Azawak zebu colostrum with literature data. The comparison was performed by a meta-analytical approach. Colostrum samples were hand-collected after 5 h from 7 Azawak cows at calving between August 27, to September 10,2009 in the Sahel. For data from literature, twenty one (21) references were identified in the following analytical databases: PubMed, Science Direct, Google scholar, Collection from University of Liege. The references were selected according to the following two criteria: i) only studies reported on bovine colostrum were used irrespective of breeds, and ii) among the selected studies, those not providing complete information to allow meta-analytical calculation were excluded. Samples were analyzed for immunoglobulins (IgG, IgM, IgA), lactoferrin, and chemical composition (dry mater, protein, fat, lactose, ash, Ca, P, NA, K, Mg). The mean levels of IgG, IgM, dry matter, protein and fat for Azawak cows were lower (P ˂ 0.001) than those obtained in other breeds; however colostrum from the Azawak was higher in IgA but the difference was not significant. For lactose and ash, mean values for Azawak cows were higher (P ˂ 0.001) than those from the literature. Contents of Ca, P, Na and Mg in Azawak bovine colostrum were significantly higher (P ˂ 0.001) than the mean levels in form the literature data. In conclusion, the colostrum from Azawak cows appears to be lower in most immunoglobulins, in fat and in protein than the values reported in the literature, but higher in lactose and minerals. This could be an adaptation to sahelian contraints.

Keywords: Azawak, bovine breeds; colostrum; chemical composition; immunoglobulin.

Résumé:

Ce travail vise à comparer les données obtenues avec le colostrum du zébu Azawak à celles obtenues dans la littérature aux fins d'une utilisation hétérologue chez les petits ruminants, et ceci en utilisant une approche méta-analytique. Des échantillons de colostrum ont été récoltés par traite manuelle au cours des vêlages entre le 27 août et le 10 septembre 2009 dans le Sahel, à partir de 7 zébus Azawak. Pour les données de la littérature, vingt et un (21) des références ont été identifiées dans les bases de données analytiques (PubMed, Science Direct, Google Scholar, Collection de l'Université de Liège). Les références ont été sélectionnées selon les deux critères suivants: i) les études rapportées sur le colostrum bovin ont été utilisées sans distinction de races, et II) parmi les études sélectionnées celles ne comportant pas des informations complètes pour permettre le calcul méta-analyse ont été exclues. Les échantillons ont été analysés pour immunoglobulines (IgG, IgM, IgA), lactoferrine, et la composition chimique (matière sèche, protéines, lipide, lactose, cendre brute, calcium, phosphore, sodium, potassium, magnésium). Les concentrations moyennes d'IgG, d’IgM de matière sèche, de protéines et matières grasses pour le zébu Azawak présentaient des valeurs plus faibles (P ˂ 0,001) que celles obtenues chez d'autres races, mais elles ont des niveaux plus élevés en IgA (P > 0,05), lactose et cendre brut (P ˂ 0,001). Les teneurs en minéraux solubles (Ca, P, K, Na et Mg) du colostrum du zébu Azawak étaient significativement plus élevées (P ˂ 0,001) que les niveaux moyens des données de la littérature recueillies. En conclusion, comparé aux données de littérature, le colostrum de vache Azawak semble être plus pauvre en immunoglobuline, en lipides et en protéines, mais plus riche en lactose et en minéraux. Il se pourrait qu’il s’agisse d’une adaptation de la race au milieu sahélien.

Mots-clés: Azawak, races bovines; colostrum; composition chimique; immunoglobulines.

Resumen:
Este estudio tiene como objetivo comparar los datos obtenidos a partir de cebú Azawak calostro con datos de la literatura, para uso heterólogo en pequeños rumiantes. La comparación se realiza, utilizando un enfoque meta-analítico. Muestras de calostro fueron recogidos a mano durante el parto entre agosto 27 y septiembre, el 10 de 2009 en el Sahel, de 7 Azawak vacas. Para los datos de la literatura, veintiuno (21) referencias se identificaron en las siguientes bases de datos analíticos: PubMed, Science Direct, Google scholar, Colección de la Universidad de Lieja. Las referencias han sido seleccionados de acuerdo con los dos criterios siguientes: i) sólo estudios informaron sobre el calostro bovino se utilizaron independientemente de razas, y ii) entre los estudios seleccionados los que no proporcionan información completa para permitir el cálculo meta-analítica fueron excluidos. Las muestras se ensayaron para inmunoglobulinas (IgG, IgM, IgA), lactoferrina, y la composición química (materia seca, proteína, lípido, lactosa, ceniza bruta, calcio, fósforo, sodio, potasio, magnesio). Los niveles medios de IgG, IgM, materia seca, proteína y grasa de vaca Azawak fueron menores (P ˂ 0,001) que los obtenidos en otras razas, pero fue mayor para IgA (P > 0,05). En el caso de la lactosa y cenizas, los valores medios de las vacas Azawak fueron más altos (P ˂ 0,001) que los de la literatura. Contenido de Ca, P, Na y Mg en Azawak calostro bovino fueron significativamente mayores (P ˂ 0,001) que los niveles medios en datos de la literatura.. El calostro de Azawak se aparece contenir menos immunoglobulin, gasa y proteína que los datos de la literatura, pero mas lactose y cenizas. A lo mejor, se podría estar un adaptacio al medio Sahelian.

Palabras clave: Azawak, bovino razas, calostro, la composición química, las inmunoglobulinas.

**Introduction**

In Niger, breeding of small ruminants is the main economic activity for more than 6 million farmers. The health of their livestock is of paramount importance. At birth, the survival of newborns is essentially determined by the ingestion of colostrum (Berge *et al.,* 2009). It provides nutrients and antibodies for the transitional protection against external aggressions, but also growth factors and hormones (Kuralkar and Kuralkar, 2010). In ruminants, a high variability and rapid changes in the composition of colostrum over time, as well as inter-specific differences have been reported (Hadjipanayiotou, 1995; Abdel-Fattah *et al.,* 2012; Hawken *et al.,* 2012). This variability may be related to factors such as nutrition (Kaewlamun *et al.,* 2011), especially during the last week before parturition (Hawken *et al.*, 2012). In addition, it is known from the literature that colostrum production is abundant in cattle, and that it is possible to use it to improve the health status of small ruminants (Godden *et al.,* 2009; Machado-Neto *et al.,* 2011). This study aimed at comparing data obtained from Azawak zebu colostrum with literature data. The comparison was performed by a meta-analytical approach. Zebu Azawak, whose females are known in Sahel for their good milking skills (Seydou, 1981) is native from north Niger (Joshi et al., 1957). This breed also spread in other countries, especially in the area of Menaka (Mali), Burkina Faso and north of Nigeria (Guro and Yenikoye, 1991). The zebu Azawak is an animal of medium size (1.3 m at the withers). In very good conditions and intensive breeding, Azawak cow can produce on average 12 liters of milk per day (Seydou, 1981). The dressing out percentage is 50 to 60% (Oumarou, 2004).

A meta-analysis was performed. Meta-analysis is a statistical method that synthesizes data from studies on a particular subject where there are contrasting results. This statistical method shows the effect of treatment in cases where the studies taken individually do not lead to a conclusion because there are no statistically significant results. Meta-analysis seeks to gather an exhaustive list of conflicting data and to remove possible mistakes. In addition, it highlights study data by comparing them with those of trials referring to similar experiments as it is the case in the present study.

**Materials and methods**

Animals

Seven multiparous cows (mean age 8 ± 0.8 years) of Azawak zebu breed were used during calving between August 27, to September 10, 2009. Animals had lactation numbers between 2 and 4. Except one animal coming from a private farm in Niamey, four (4) cows were from the Farm Station of Kirkissoye (FSK) in Niamey and two (2) from the Sahelian experimental station of Toukounous (SSET) located 200 km North of Niamey (14°31 North and Longitude 3°18 East). They were vaccinated against Contagious Bovine Pleuropneumonia (CBPP). At FSK, farming was conducted in stables where the main diet consists of *Echinochloa stagnina* complemented, with wheat, cottonseed, cottonseed meal, peanut meal, brewer's spent grains and licks. Feed was done *ad libitum*. Animals of SSET were on pasture, dominated by grasses (*Aristida mutabilis, ,Cenchrus biflorus, Eragrostis tremula, Schoenfeldia gracilis, Panicum laetum*) and woody (*Maerua crassifolia, Salvadora persica*), according to Chaibou (2005). Pregnant and lactating females were supplemented with cotton seed (2 kg) during the dry season.

Colostrum collection

Colostral samples were taken in the first 5 hours after calving by hand milking before calves suckled, collected in containers and packed in appropriate tubes, being stored in a freezer at -20°C before analysis. The cold chain was never interrupted during this period. During the journey from Niamey to Liege, samples were taken in a thermos with ice.

Chemical analysis

Immunoglobulin (Ig) and lactoferrin (Lf) contents (g/L) in colostrum were measured at the Center of Rural Economy of Marloie (Belgium) by ELISA, following the manufacturer's recommendations (Bethyl® quantitative sandwich ELISA, USA). Dry matter (DM), crude ash, nitrogen-free extract (NFE), ether extract (EE) and total nitrogenous matter (TNM) were measured according to the methods of the Association of Official Analytical Chemists (AOAC, 2006). Calcium (Ca) and magnesium (Mg), were determined by atomic absorption, potassium (K) and sodium (Na) by flame emission and phosphorus (P) by spectrophotometry.

Meta-analytic data collection

Meta-analytical means were calculated from data collected from the literature. Only studies on bovine colostrum were used, regardless of breed. Among the selected studies, those not providing complete information to allow meta-analytical calculation were excluded. In other words, all studies that do not indicate the number of animals used or in which average values are not accompanied by indicators of variation (standard deviation, standard error) were discarded. Twenty one (21) references were identified in analytical databases (PubMed, Science Direct, Google scholar, Collection from University of Liege). Table 1 summarizes the materials (animals and experimental design) used by the authors during their studies. It refers to number of animals used, area or country, time of colostrum collection after birth, stage of lactation, and feed.

Data Analysis

Averages and standard deviations of data were calculated.

Meta-analytical data were obtained according to the method proposed by Cucherat *et al.* (2000), in which a literature general mean is obtained by the following formula:



Where:

*Mi* = published mean related to author i.

*Wi* = the inverse of the variance of the mean associated with Mi.



*ni* = number of animals used to obtain the published value Mi.

*S2* = Variance of the mean *Mi.*

When the standard deviation (SD) was available, Wi was calculated as ni/SD².

When the standard error (SE) was available, Wi was computed as 1/SE2.

Finally, the confidence interval of the meta-analytic mean (CI) was estimated by:

,  representing the synthetic SE from the literature.

The experimental and meta-analytic means were finally compared by the student’s t-test.

**Results**

Figure 1 presents the mean levels ± standard error of immunoglobulins and lactoferrin in the colostrum of Azawak and other bovine breeds. The value for IgA, obtained in the current study was numerically higher than the mean value of the synthesized data. For IgG and IgM, the mean value of data obtained in the literature was significantly higher (P ˂ 0.001) than the mean obtained for Azawak, while for lactoferrin the means were not significantly different (0.2 ± 0.1 g/L vs 0.03 ± 0.3 g/L).

In the case of DM, the mean of data reported in literature was significantly higher (P ˂ 0.001) than that of Azawak (Figure 2). For protein and fat, the mean levels found in the literature were also higher (P ˂ 0.05) than those of Azawak zebu cows (Figure 2). In the case of lactose and ash, mean values of Azawak cows were higher (+12,2 g/kg DM; +1,3 g/kg DM; P ˂ 0.001 respectively) than those from literature.

As far as soluble minerals are concerned, colostrum contents from Azawak for Ca, P, K, Na and Mg were significantly higher (+0.7 g/kg DM; + 0.9 g/kg DM; +0.1 g/kg DM, + 0.3 g/kg DM; + 0.2 g/kg DM P ˂ 0.001 respectively) than the mean levels of literature data (Figure 3).

**Discussion**

The meta-analysis showed that the average values of the synthesized data were significantly higher than that of Azawak zebu for immunoglobulin (IgG and IgM), DM, protein and ether extract. By contrast, IgA, lactose, ash and all soluble mineral contents observed in the Azawak colostrum were numerically or significantly higher than those reported in other breeds of cattle. These differences may be related to several factors. It is well known that nutrients, minerals and immunoglobulin in colostrum vary according to rank of lactation (Zarculas *et al.,* 2010; Abdou *et al.,* 2012), breed, nutritional status (Kaewlamun *et al.,* 2011), climate (Westra and Wahyudi, 2009), and season (Abdel-Fattah *et al.,* 2012).

At first sight, these variations may be related to *pre-partum* (pregnancy) management of cow. The antibody concentration may vary due to a period of abnormal dry, or non stop milking before calving, or pathogen pressure. It was reported in literature (Brandon and Lascelles, 1975; Remond *et al*., 1997; Rastani *et al.,*2005) that cows which are milked during late pregnancy do not renew their secretory epithelium and are unable to concentrate their IgG1 secretion. According to Serieys (1993), in cows, a minimum of 25 days of drying is necessary for a renewal of the mammary epithelium cells that are responsible for the transfer and accumulation of Ig in the udder.

The rank of lactation could probably not explain thr results of this study because the two groups of animals were generally at a similar rank (2-4). However, it is possible to establish a relationship between breed and the effects observed. It is known from the literature (West, 2003; Chaibou, 2005) that breeds in tropical countries have a lower genetic merit than those in areas with temperate climates. The majority of breeds listed in this meta-analysis are from countries with temperate climates. This may explain the low level of some Ig in Azawak bovine colostrum (Nardone *et al.,* 1997 ; West, 2003).

Environmental (Nardone *et al.,* 1997; West, 2003) effects, particularly feed, could also explain the difference in Ig observed between Azawak cow and other breeds. Although Azawak cows are reared on farms, their maintenance requirements are provided through natural pasture and crop residues with low nutritional value and agro-industrial by-products. Breeding conditions are so precarious that the animals are hardly able to fulfill all of their performances. In addition, climatic factors could directly affect animal performance (West, 2003) since they interfere with homeothermy. Prolonged hyperthermic stress causes a reduction in the secretion of many hormones (thyroxine, growth hormone, insulin, sex hormones, prolactin) involved in the metabolism (Wolfensohn *et al.,* 1988; Collier *et al.,* 1991).

It appears that changes in these hormones are sensitive to change (high or low) in prevailing temperature. Thermal variation in Niger ranges from a minimum of 25°C and a maximum of 45 and even 47°C. It is possible that in the Azawak cow, the levels of some hormones involved in the mechanism of colostrum secretion were reduced. All these reasons indicated above could explain the differences observed between the composition of Azawak cow colostrum and that of other breeds used in the meta-analysis. Several studies (Hadjipanayiotou, 1995; Abdel-Fattah *et al.,* 2012; Hawken *et al.,* 2012) have focused on changes in the chemical composition of cow colostrum after calving. Thus, the variations observed could be finally attributed to factors such as endocrine hormones alteration. It is known that estrogens, especially 17-estradiol, the serum concentration of which increases during the dry period, achieve a peak just before parturition, and have an essential role in the development of new mammary epithelial cells (Derivaux *et al.,* 1976; Tuker, 2000), which also possess receptors for IgG1 (Serieys, 1993). A study conducted by Sheldrake *et al.* (1984) showed that exogenous 17-estradiol and progesterone in non-pregnant dry cows induce a lobulo-alveolar development of the mammary gland. In a previous study, Delouis (1978) found that rapid induction of parturition in cows in late gestation by administration of corticosteroids or a combination of steroids and estradiol may bring colostrum a best one.

Regarding the determination of immunoglobulins (IgG, IgA, and IgM) and lactoferrin, some authors used the radial immunodiffusion technique while others applied the ELISA method, but from different manufacturers. For example, Elfstrand *et al.* (2002) measured all individual colostrum samples through the IR technique (CombiFoss 5000, Foss Electric A/S, and Hillerïod, Denmark). Nutrients (protein, fat, lactose, ash) and soluble minerals (Ca, P, K, Na, and Mg) were analyzed with methods similar to those used in the current study.

By contrast to other Ig whose levels from Azawak were lower than synthesized data, the average IgA concentration in the current study was similar to literature. There exists relationships between IgA production and the exposure of mucosas of the mother to external antibody. May be a high ambient infectious pressure existing in Niger could explain the proportionaly higher IgA levels when compared to IgG and IgM. The average concentration of lactoferrin in Azawak bovine colostrum was similar to that obtained in the colostrum of cattle breeds used in the meta-analysis.

Colostrum quality can also be influenced by diseases such as mastitis (Maunsell *et al.,* 1998) or/and dietary imbalance (e.g., vitamin E or selenium) during the dry period (Zarcula *et al.,* 2010). The differences observed between the Azawak cows and the mean of synthesis data from the literature can be also explained either by the fact that the Azawak cow would naturally tend to produce a rather poor colostrum dry matter , in order to bring out quickly water to his young. Colostrum sampling could also be performed too late relative to calving but it is not the case in this experiment. It is also clear that the distribution of means from the literature, although normal, was very narrow. However, the statistical test used in meta-analysis take into account this phenomenon. Moreover, the larges differences between the meta-analytical mean and the mean of our measures remain a reality.

Colostrum of goat tends to be poorer in solids and immunoglobulins than cow (Hadjipanayiotou 1995; Levieux et al , 2001; Machado -Neto et al , 2011 ). It can therefore be inferred that the kid could tolerate adequately the Azawak colostrum. However there are some uncertainties with respect to the justification of using Azawak colostrum in goats, based only on the dry matter content. Further experiments should be performed in that senses.

**Conclusion**

The current study has shown that the level of antibodies and nutrients in Azawak colostrum is lower to those reported in the literature. By contrast, for IgA, lactose and soluble minerals, are at similar levels or significantly different in favor of Azawak cow. In conclusion, the colostrum from Azawak cows appears to be lower in most immunoglobulins, in fat and in protein than the values reported in the literature, but higher in lactose and minerals. This could be an adaptation to the sahelian constraints. What is the practical application of these results?

**Acknowledgements:**

This work was funded by the Belgian Technical Cooperation (BTC). The authors wish to thank the organization. My thanks are also addressed to the laboratory team of Marloie (Belgium) for their collaboration.

**References**

Abdou, H., Marichatou, H., Beckers J-F., Dufrasne, I. & Hornick, J-L. 2012. Physiologie de la production et composition chimique du colostrum des grands mammifères domestiques: généralités. *Annales Médecine Vétérinaire* 156**:** 87-98.

Abdel-Fattah, A.M., Abd-Rabo, F.H.R., El-Dieb, S.M. & El-Kashef, H.A. 2012. Changes in composition of colostrum of Egyptian buffaloes and Holstein cows. *Veterinary Research* 8, 19.

Andrew, S.M. 2001. Effect of Composition of Colostrum and Transition Milk from Holstein Heifers on Specificity Rates of Antibiotic Residue Tests. *Journal of Dairy Science* 84: 100-106.

AOAC, 2006. *Association of Official Analytical Chemists, Official methods of analysis,* K-INTDF, 18th edition, Arlington, VA, USA, 28p.

Beighle, D.E. 1999. The effect of gestation and lactation on bone calcium, phosphorus and magnesium in dairy cows. *Journal of the South African Veterinary Association* 70: 142-146.

Berge, A.C.B., Besser, T.E., Moore, D.A. & Sischo, W.M. 2009. Evaluation of the effects of oral colostrum supplementation during the first fourteen days on the health and performance of preweaned calves. *Journal of Dairy Science* 92: 286-295.

Brandon, M.R., Lascelles, A.K. 1975. The effect of pre-partum milking on the transfer of immunoglobulin into mammary glands of cows. *Australian Journal of Experimental Biology & Medical Science* 53: 197-204.

Chaibou, M. 2005. *Productivité zootechnique du désert: le cas du bassin laitier d'Agadez au Niger* (Thèse de Doctorat ès sciences). Université de Montpellier II, Montpellier, France, 379p.

Collier, R.J., Miller, M.A., Hildebrandt, J.R., Torkelsson, A., White,T.C., Madsen, K.S., Vicini, J.L., Eppard, P.J. & Lanza, G.M. 1991. Factors affecting insulin-like growth factor-2 concentration in bovine colostrum. *Journal of Dairy Science* 74: 2905-2911.

Cucherat, M., Haugh, M.C., Gooch, M. & Boissel, J.P. 2000. Evidence of clinical efficacy of homeopathy. A meta-analysis of clinical trials. HMRAG. Homeopathic Medicines Research Advisory Group. *European Journal of Clinical. Pharmacology* 56: 27-33.

Delouis, C. 1978. Physiology of colostrum production. *Annales de. Recherches Vétérinaire* 9: 193-203.

Derivaux, J., Ectors, F. & Beckers J.F. 1976. Données récentes en gynécologie animale. *Annales Médecine Vétérinaire* 120: 81-102.

Elstrand, L., Lindmark-Manssom, H., Paulssona, M., Nybergc, L., & Akesson, B. 2002. Immunoglobulin’s growth factors and growth hormone in bovine colostrum and the effects of processing*.* *International Dairy J*ournal 12: 879-887.

Ferdowsi Nia, E., Nikkhah, A., Rahmani, H.R., Alikhani, M., Mohammad Alipour, M. & Ghorbani, G.R. 2010. Increased colostral somatic cell counts reduce pre-weaning calf immunity, health and growth. *Journal of Animal Physiology and Animal Nutrition* 94: 628-634.

Gergiev, I.P. 2005. Alterations in chemical composition of colostrum in relationship to post-partum time. *Bulgarian Journal of Veterinary Medicine* 8: 35-39.

Godden, M., Haine, D.M., Konkol, K. & Peterson, J. 2009. Improving passive transfer of immunoglobulin in calves. II: Interaction between feeding method and volume of colostrum fed. *Journal of Dairy Science* 92: 1758-1764.

Gouro, S.A. & YENIKOYE A. 1991. Etude préliminaire sur le comportement d'œstrus et la progestéronémie de la femelle zébu (Bos indicus) Azawak au Niger. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux **1**: 100-103.

Hadjipanayiotou, A.M. 1995. Composition of ewe, goat and cow milk and colostrum of ewe and goat. *Small Ruminant Research* 18: 255-262.

Hawken, P.A.R., Williman, M., Milton, J., Kelly, R., Nawak, R. & Blachea, D. 2012. Nutritional supplementation during the last week of gestation increased the volume and reduced the viscosity of colostrum produced by twin bearing ewes selected for nervous temperament. *Small Ruminant Research* 105**:** 308-314.

Joshi N.R., Mclaughline, .A., Phillips, R.W. 1957. Les bovins d’Afrique, types et races. FAO, Rome, Italie 317 p.

Kaewlamun, W., Okouyi, M., Humblotd, P., Remy, D., Techakumphu, M., Duvaux –Ponter, C. & Pontera, A.A. 2011. The influence of a supplement of β-carotene given during the dry period to dairy cows on colostrum quality, and β-carotene status, metabolites and hormones in newborn calves. *Animal Feed Science and Technology* 165: 31-37.

Klimes, J., Jagos, P., Bouda, J. & Gajdusek, S.1986. Basic quantitative parameters of cows colostrum and their dependence on season and post partum. *Acta Veterinaria Brno* 55: 23-39.

Klobasa, F., Goel, M.C., Werhahn, E. 1998. Comparison of freezing and lyophilizing for preservation of colostrum as a source of immunoglobulins for calves. *Journal Animal Science* 76: 923-926.

Kunes, S., Yamamoto, E., Kudo, T., Toharmat, T. & Nonaka, I. 1998. Effect of Parity on mineral Concentration in Milk and Plasma of Holstein Cows during Early Lactation. *Association Juris Affaires Santé* **11:** 133-138.

Kuralkar, P. & Kuralkar, S.V. 2010. Nutritional and Immunological Importance of Colostrum for the new born. *Veterinary World* 3: 46-47.

Machado-Neto, R., Grigolo, I.H., Moretti, D.B., Kindlein, L.& Pauletti, P. 2011Intestinal histology of Santa Ines lambs fed bovine or ovine colostrum. *Czech Journal of Animal Science* 56: 465-474.

Maunsell, F.P., Morin, D.E., Constable, P.D., Hurley, W.L., McCoy G.C., Kakoma, I.& Isaacson, R.E. 1998. Effects of Mastitis on the Volume and Composition of Colostrum Produced by Holstein Cows. *Journal Dairy Science* 81: 1291-1299.

Morill, K.M., Conrad, E., Lago A., Campbell, J., Quigley, J. & Tyler, H., 2012. Nationwide evaluation of quality and composition of colostrum on dairy farms in the United States. *Journal Dairy Science* 95:3997-4005.

Nardonne, A., Lacetera, N., Bernabucci, U. & Ronchi, B. 1997. Composition of Colostrum from Dairy Heifers Exposed to High Air Temperatures During Late Pregnancy and the Early Postpartum Period1. *Journal of Dairy Science* 80: 838-844.

Oumarou, A. 2004. Production laitière et croissance du zébu Azawak en milieu réel: suivi et évaluation technique à mis parcours du projet d’appui à l’élevage des bovins de races Azawak en zone agropastorale au Niger (Thèse de doctorat vétérinaire). École Inter-États de sciences et médecine vétérinaire de Dakar: Dakar, 82p.

Ontsouka, C.E., Bruckmaier, R.M. & Blum, J.W. 2003. Fractionized Milk Composition During Removal of Colostrum and Mature Milk. *Journal of Dairy Science* 86: 2005-2011.

Parrish, D.B., Wise, G.H., Hughes, J.S. & Atkeson, F.W. 1950. Properties of the colostrums of the dairy cow. V yield, specific gravity and concentrations of total solids and its various components of colostrums and milk. *Journal of Dairy Science* 33: 457-465.

Quigley, J.D. & Martin, K.R., 1994. Immunoglobulin Concentration, Specific Gravity, and Nitrogen Fractions of Colostrum from Jersey Cattle. *Journal of Dairy Science* 77: 264-269.

Quigley, J.D., Martin, K.R. & Dowlen, H.H. 1995. Concentrations of Trypsin Inhibitor and Immunoglobulins in Colostrum of Jersey Cows. *Journal of Dairy Science* 78: 1573-1577.

Rastani, R.R., Grummer, R.R., Bertics, S.J., Gumen, A., Wiltbank M.C., Mashek, D.G. & Schwab, M.C. 2005. Reducing dry period length to simplify feeding transition cows: milk production, energy balance, and metabolic profiles. *Journal of Dairy Science* 88: 1004-1014.

Remond, B. & Bonnefoy, J.C. 1997. Performance of a herd of Holstein cowsmanaged without the dry period. Annales de Zootechnie 46: 3-12.

Sacerdote P., MUSSANO F., FRANCHI S., PANERAI A.E., BUSSOLATI G., CAROSSA S., BARTORELLI A., BUSSOLATI B., Biological components in a standardized derivative of bovine colostrum. *J. Dairy Sci.,* 2013, **96**, 1745-1754.

Serieys, F. 1993. Le colostrum de vache. Smithkline-Beekham: Ploufragan, 88 p.

Seydou, B. 1981. Contribution à l’étude de la production laitière du zébu Azawak au Niger (Thèse de doctorat vétérinaire). École Inter-Étass de sciences et médecine vétérinaire de Dakar: Dakar, 102p.

Sheldrake, R.F., [Husband, A.J](http://www.ncbi.nlm.nih.gov/pubmed?term=Husband%20AJ%5BAuthor%5D&cauthor=true&cauthor_uid=6690604)., [Watson, D.L](http://www.ncbi.nlm.nih.gov/pubmed?term=Watson%20DL%5BAuthor%5D&cauthor=true&cauthor_uid=6690604). & [Cripps, A.W](http://www.ncbi.nlm.nih.gov/pubmed?term=Cripps%20AW%5BAuthor%5D&cauthor=true&cauthor_uid=6690604). 1984. Selective transport of serum-derived IgA into mucosal secretions. *Journal of Immunology* 132: 363-368.

Stott, G.H., Fleenor, W.A. & Kleese, W.C. 1981. Colostral Immunoglobulin Concentration in Two Fractions of First Milking Postpartum and Five Additional Milking. *Journal of Dairy Science* 64: 459-465.

Strekozov, N.I., Motova, E.N. & Fedorov, Y.N. 2008. Evaluation of the chemical composition and immunological properties of colostrum of cows' first milk yield. *Russian Agricultural Science* 34**:** 259-260.

Tsloulpas, A., Grandison, A.S. & Lewis, M.J. 2007. Changes in Physical Properties of Bovine Milk from the Colostrum Period to Early Lactation. *Journal of Dairy Science* 90: 5012-5017.

Tucker, H.A. 2000. Hormones, mammary growth, and lactation: a 41-year perspective. *Journal of Dairy Science* 83: 874-884.

West, J.W. 2003. Effects of heat-stress on production in dairy cattle. *Journal of Dairy Science* 86: 2131-44.

Westra, I.G.K.P. & Wahyudi, I. 2009. The Effects of Tropical Climate Stressor on Gamma Immunoglobulin Concentration. *Animal Production* 11: 143-148.

Wolfenson, D., Flamenbaum, I. & Berman, A. 1988. Dry period heat stress relief effects on prepartum progesterone, calf birth weight, and milk production. *Journal of Dairy Science* 71: 809-818.

Zagorska, J., Indra Eihvalde I., Gramatina, I. & Sarvi, S. 2011. Evaluation of colostrums quality and new possibilities for its application. In 6th Baltic Conference on Food Science and Technology. Latvijas Lauksaimniecības Universitātes Pārtikas Tehnonoloģijas fakultātes un rakstu autoru īpašums un tā saturs nav, page 45-49.

Zarculas, S., Cernescu, H., Mircu, C., Tulcan, C., Morvay, A., Simona Baul, S. & Daniel, P. 2010. Influence of Breed, Parity and Food Intake on Chemical Composition of First Colostrum in Cow. *Animal Science Biotechnology* 43: 154-157.

Table 1. List and characteristics of the 21 references identified in analytical databases.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| REFERENCES | Bovine breed | Country | NA | TCAB (h) | Feed |
| Parrish *et al.,* 1950 | Holstein | USA | 10 | 3 | Concentrate mixture, Atlas sorgo silage and hay |
| Stott *et al.,* 1979 | Holstein | USA | 12 | BFM | - |
| Klimes *et al.,* 1986 | Bohemian Pied Lowland | Czech Republic | 13 | 2 to 4 | - |
| Quigley and Martin, 1994 | Jersey  | USA | 88 | BFM | - |
| Quigley *et al.,* 1995 | Jersey  | USA | 49 | BFM | Pasture. |
| Nardone *et al.,* 1997 | Holstein | Italy | 6 |  | Mixture of forages and concentrates on an *ad libitum* basis. |
| Maunsell *et al.,* 1998 | Holstein | USA | 33 | BFM | - |
| Klobasa *et al.*, 1998 | Holstein-Friesian | Germany | 8 | NI | - |
| Kune *et al.,* 1998 | Holstein | Japan | 24 | BFM  | Mixed ration |
| Beighlea, 1999 | Friesian cows | South African | 60 | NI | Animals were fed *ad libitum* a mixture of 50 % Lucerne and 50 % blue buffalo grass. |
| Andrew, 2001 | Holstein Heifers | USA | 25 | 0 to 6 | - |
| Elfstrand *et al.,* 2002 | Swedish Friesian | Sweden | 20 | 0 to 6 | - |
| Ontsouka *et al.,* 2003 | Red Holstein | Switzerland | 60 | BFM | Consisting of grass silage, hay, and concentrates. |
| Georgiev, 2005  | Cows (Black and white) | Bulgaria | 5 |  | Consisting of alfalfa, maize silage, brewers grain and concentrates. |
| Tsioulpas *et al.,* 2007 | Friesian cows | UK | 8 | 1 to 3 | - |
| Strekozov *et al.,* 2008 | Black Pied third | Russia | 43 | 1 | - |
| Ferdowski Nia *et al.,* 2010 | Holstein  | Iran | 69 | 1 | - |
| Zagorska *et al.,* 2011 | Latvian Brown (76%) | Lettonia | 29 | NI  | - |
| Morrill *et al.,* 2012 | Holstein  | USA | 494 | NI | - |
| Abdel-Fattah *et al.,* 2012 | Holstein  | Egypt | 12 | 6 | Rice straw and concentrate (16% protein), and housed in free stalls. |
| Sacerdote *et al.,* 2013 | Holstein | Italy | 30 | 1 to 12  | Mix containing wheat and corn silage mix plus 25.7% row proteins and 2.4% row fats)  |

BFM: before first milking; NA: number of animals; NI: no information; TCAB: time collection after birth.

Figure 1. The mean level concentration ± standard deviation (SD) of immunoglobulins in colostrum of Azawak cow (n= 7) and other bovine breeds (21 references).

Figure 2. The mean level concentration ± standard deviation (SD) of dry matter and nutrients in colostrum of Azawak cow (n= 7) and other bovine breeds (21 references).

Figure 3: The mean level concentration ± standard deviation of soluble minerals in colostrum of Azawak cow and other bovine breeds.