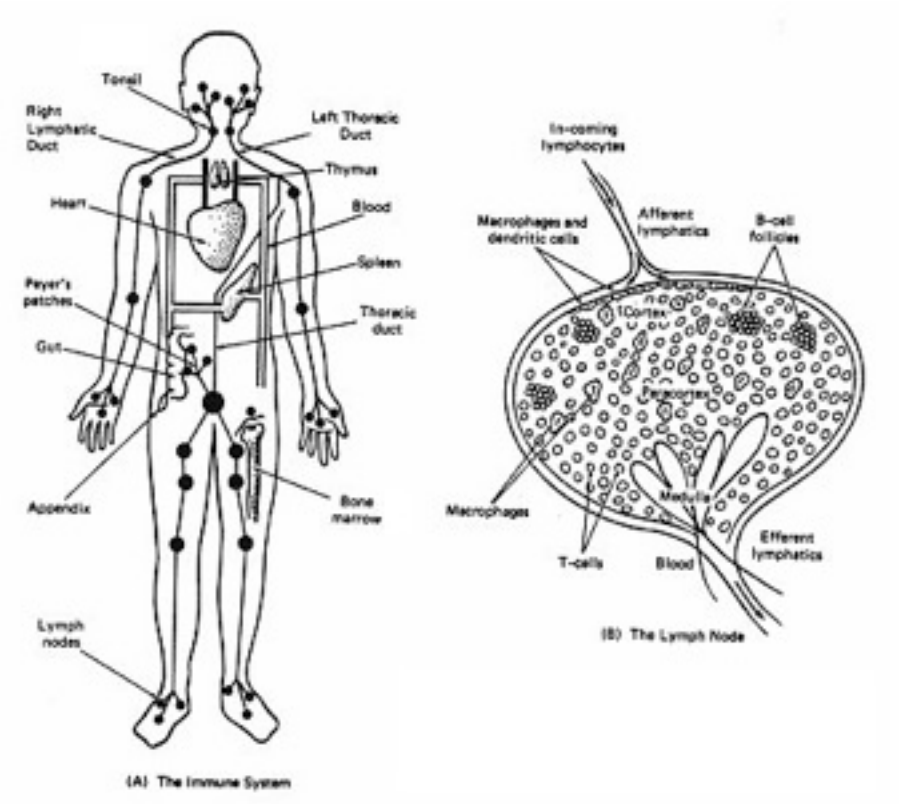
Camel Milk and Autoimmune Diseases: Historical Medicine



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SUMMARY

This document presents the connection between the performance of the normal immune system, autoimmune diseases and camel milk therapy.

The immunoglobulins (Igs) are large long and short-chained domains, having difficulties reaching and penetrating antigens. Camel immunoglobulins have no short chains and small so are active against antigens. The camel's immunoglobulins pass into the milk and so are available for combating autoimmune diseases.

The most pertinent factor is that conventional treatments of autoimmune diseases are based on immune-suppression, while camel milk Igs enhance the immune system, revitalizing immune integrity.

Camel milk was first mentioned in the Moslem Holy Scriptures as being a gift for hungry people and a remedy for sicknesses. This claim is still valid today and, therefore, can be considered an natural and historic treatment.

The Prophet Muhammed considered camels' milk medicinal (Bukhari 7:71 "Medicine" #589 and #590). Scientists theorize that it is due to the immune system.

INTRODUCTION:

Before presenting the basis for the effective control of autoimmune diseases by camel milk, it is imperative to understand the human immune system, the causes of its malfunction, the current therapies and the make-up of the camel immune system.

IMMUNE SYSTEM:

"**Immune**" means "protection from".

The immune system is a complicated network of cells and cell components called molecules that normally work to defend the body and eliminate infections caused by bacteria, viruses, and other invading microbes.

Most immune system cells are **white blood cells**, of which there are many types. **Lymphocytes** are one type of white blood cell, and two major classes of lymphocytes are **T cells** and **B cells**. T cells are critical immune system cells that help to destroy infected cells and coordinate the overall immune response. The T cell has a molecule on its surface called the T-cell receptor. This receptor interacts with molecules called MHC (major histocompatibility complex). MHC molecules are on the surfaces of most other cells of the body and help **T cells recognize antigen fragments**. **B cells are best known for making antibodies**. Other types of white blood cells include **macrophages** and **neutrophils**.

Macrophages and neutrophils circulate in the blood and survey the body for foreign substances. When they find foreign substances, antigens, such as bacteria, they engulf and destroy them. Macrophages and neutrophils destroy foreign antigens by

making toxic molecules such as reactive oxygen intermediate molecules. If production of these toxic molecules continues unchecked, not only are the foreign antigens destroyed, but surrounding tissues as well.

ANTIBODIES:

Humoral Immunity refers to the production of **antibody molecules in response to a specific antigen**. After an appropriate signal from a T-cell the antibody binds with the antigen and marks it for destruction by other immune system cells. Humoral immunity is **most effective against bacteria, bacterial toxins, and viruses prior to these agents entering cells**.

Antibody Structure:

There are 5 classes of human antibodies: **IgG, IgM, IgA, IgD, and IgE**. The simplest antibodies, such as IgG, IgD, and IgE, are "Y"-shaped macromolecules called monomers. A monomer is composed of **four glycoprotein chains**: two identical **heavy chains** and two identical **light chains**. The two heavy chains have a high molecular weight that varies with the class of antibody. The light chains come in two varieties: kappa or lamda and have a lower molecular weight. The four glycoprotein chains are connected to one another by disulfide (S-S) bonds and non-covalent bonds.

The amino acid sequence of the first domain of both the light chain and the heavy chain shows tremendous variation from antibody to antibody and constitutes the **variable domains** of the antibody.

Antibodies of the classes **IgG, IgD, and IgE are monomers** while **IgM** is a **pentamer** and **IgA** is a **dimmer**.

Immune Complexes and the Complement System

When many antibodies are bound to antigens in the bloodstream, they form a large lattice network called an immune complex. Immune complexes are harmful when they accumulate and initiate inflammation.

A large immune complex.

Immune complexes, immune cells, and inflammatory molecules can block blood flow and ultimately destroy organs such as the kidney. This can occur in people with systemic lupus erythematosus.

If immune complexes accumulate in the kidney, they may promote movement of other inflammatory cells and molecules into the kidney.

A group of specialized molecules that form the complement system helps to remove immune complexes. The different types of molecules of the complement system,

which are found in the bloodstream and on the surfaces of cells, make immune complexes more soluble. Complement molecules prevent formation and reduce the size of immune complexes so they do not accumulate in the wrong places (organs and tissues of the body).

The word "**auto**" is the Greek word for self..

Autoantibodies

In some autoimmune diseases, B cells mistakenly make antibodies against tissues of the body (self antigens) instead of foreign antigens. Occasionally, these autoantibodies either interfere with the normal function of the tissues or initiate destruction of the tissues. Chemokines are small cytokine molecules that attract cells of the immune system. Overproduction of chemokines contributes to the invasion and inflammation of the target organ, which occurs in autoimmune diseases

In an autoimmune disease, the immune system mistakes self tissues for non-self and mounts an inappropriate attack, resulting in an autoimmune disease. **The immune system creates antibodies against its own tissues**.

Autoimmune diseases can affect the body in different ways. For instance, the autoimmune reaction is directed against the brain in multiple sclerosis and the gut in Crohn's disease. In other diseases, such as systemic lupus erythematosus (SLE), various tissues and organs may be effected in different individuals with the same disease.

Many autoimmune diseases are rare. Most autoimmune diseases strike women more often than men, particularly affecting women during their childbearing years.

The development of an autoimmune disease may be influenced by inherited genes together with the way the immune system’s response to certain triggers (eg. viral diseases).

What causes the immune system to short-circuit and start rejecting normal body tissue? Many theories exist, but the ultimate answer is "We don't know." Jean Dodds (1992), a veterinarian studying immunology, feels that multivalent, modified-live vaccines overstimulate the immune system, a theory suggested for the cause of autism.

TREATMENT OF AUTOIMMUNE DISEASES:

Autoimmune diseases are often chronic, requiring lifelong care and monitoring, even when the person may look or feel well. Currently, few autoimmune diseases can be cured or made to “disappear" with treatment. Many people with these diseases can live normal lives when they receive appropriate medical care.

The goal of scientific research is to prevent inflammation from causing destruction. In some diseases medication can occasionally slow or stop the immune system's destructive actions.

These are referred to as **immunosuppressive** medications.

Treatments to reduce symptoms may include:

* nonsteroidal anti-inflammatory drugs (NSAIDs), including aspirin or ibuprofen, to relieve fever, joint pain, and muscle aches

* corticosteroids, or steroids, help reduce inflammation. These medications are often used on a short-term basis for a sudden episode or flare-up.

* medications to suppress the immune system, such as methotrexate, azathioprine, and cyclophosphamide, which help to reduce inflammation and organ damage

Unfortunately, these medications also suppress the ability of the immune system to fight infection and have potentially serious side effects.

Autoimmune Inc. is a biopharmaceutical company developing a new class of **orally** administered products to treat autoimmune and other cell-mediated inflammatory diseases. Each of these products is based on a common biological mechanism known as oral tolerance, which provides tissue specific **immunosuppression** to control disease without toxicity or significant side effects (AutoImmune Inc. Pasadena, CA 91103).

PERSONAL OBSERVATIONS (RY) OVER THE PAST 5 YEARS SUGGEST THAT AUTOIMMUNE DISEASES ARE CONTROLLED OR EVEN HEALED BY DRINKING CAMEL MILK.

CAMEL IMMUNE SYSTEM:

IgM, IgG, IgA and even IgD have been detected in camel sera on the basis of cross-reactivity with human immunoglobulins (Hamers, 1998).

In 1993 Hamers-Casterman et al described the amazing camel immune system, different from all other mammalians. Subclasses IgG2 and IgG3 (natural for camels) consist of only two heavy chains. Light chains (VL) are not present. There is a single V domain (VHH) (Riechmann & Muyldermans, 1999). Camel VHH have a long complementary determining region (CDR3) loop, compensating for absence of the VL (Muyldermans et al, 2001).

Conventional antibodies rarely show a complete neutralizing activity against enzyme antigens. **Camel IgG has a full neutralizing activity** against tetanus toxin as it enters the ezymes structure. Camel hypervariable regions have increased repertoire of antigen binding sites (Muyldermans et al, 2001). Camel VHH domains are better suited to enzyme inhibitors than human antibody fragments (Riechmann & Muldermans, 1999), thus **offering a potential for viral enzymatic neutralization** (Hoelzer et al, 1998; El-Agamy, 2000)**.**

A major flaw in the development of human-immunotherapy is the size of the antibodies. Larger antibodies cannot reach their target.

CAMEL ANTIBODIES ARE ONE TENTH OF THE SIZE OF HUMAN ONES (natural nanobodies).

The comparative simplicity, high affinity and specificity of camel Igs, and the potential to reach and interact with active sites allow for penetration of dense tissues to reach the antigen.

VIRAL DISEASES:

Viral enzymes play a key role in triggering diseases, and by neutralizing them a replication of viruses would stop. A camel variable domain antibody fraction of is a potent and selective inhibitor of the Hepatitis C enzyme system (Martin et al, 1997).

This explains the extreme resistance to many deadly animal viral diseases like Foot & Mouth, Rift Valley fever and Rinderpest (Hamers et al, 1998).

THE LARGE NUMBER OF VIRAL ANTIBODIES IN CAMEL SERUM AND MILK SUGGESTS THAT THEY HAVE BEEN EXPOSED TO DISEASES BUT NOT INFECTED.

Microbial diseases such as leptospirosis, glanders, lymphangitis, mastitis, pasteurellosis, paratuberculosis, tetanus, botulism, clostridia and rickettsia are of very minor importance in camels (Koerhler-Rollefsen et al, 2001)

CAMEL (CAMELUS DROMEDARIUS) MILK:

Besides the nutritive value of camel milk, which is extremely well adapted for human requirements, there appears to be an additional factor: the medicinal, or **NATURAL HEALING** properties of the milk. In addition to folklore tales (Yagil, 1982), there are tuberculosis clinics treating TB with camel milk (Urazakov & Bainazarov, 1974); diabetes mellitus is being treated with camel milk and there also have been reports on the use of camel milk on liver function (Sharmanov et al. 1978; Zagorski et al, 1998; Zhangabilov et al, 2000).

The tuberculosis treatment used milk of the two-humped bactrian camel (Camelus bactrianus) while diabetes was treated with milk of the one-humped dromedary (Camelus dromedarius) although it has been established that dromedary milk also has a beneficial effect on tuberculosis, especially those suffering from multiple drug resistance (Gorakh et al, 2000; Alwan & Farhuni, 2000).

➡It is pertinent to note that whereas nomads in Africa and India boil the milk of cows and goats they do not dos with camel milk. This is true for most nomadic camel communities. It would explain why camels suffer few diseases, their milk is free of pathogens and it has ben empirically noted that heat destroys the beneficial aspects of the milk, especially immunoglobulins (Koehler-Rollefson et al, 2001).

CAMEL MILK COMPOSITION:

Research on milk of the one-humped camel has been done in greater detail than that of the two-humped camel (Yagil & van Creveld, 2000).

Dromedary milk is pure white as the **fats** are finely homogenized throughout the milk; the milk is low fat -2% (Yagil, 1985) and the fats consist mainly of PUFAs - long-chained poly unsaturated fatty acids (Abu-Lehiya, 1987); it has a relatively low **pH** (Yagil et al, 1984) probably caused by the high concentrations of ascorbic acid - **vitamin C** (Yagil, 1985; Farah, 1996); **proteins** are present at 3.2% but **lack the ALLERGENIC** beta lactoglobulin and have a different, “new” beta casein (Beg et al, 1986); there are **bacteriostatic** and **viricide** activities of the milk (Barbour et al, 1984; El-Agamy et al, 1993); **lactose** appears in similar percentages to cow milk but lactose intolerant people do not exhibit the typical signs after drinking camel milk (Jack Hanna’s Animal Adventures).

Camel milk has high concentrations of calcium and iron so the low pH of the milk (from the ascorbic acid - vitamin C) allows enhanced absorption from the duodenum.

INSULIN IN MILK:

(a) Camel milk contains large concentrations of insulin - 150 U/ml (Zagorski et al, 1998);

(b) Fasted and dehydrated rats and rabbits had a decline in blood sugar after receiving camel milk. As fasting nullifies insulin secretion, the drop in blood sugar indicates insulin activity.

It must be noted that fasted rabbits used to be the bioassay for insulin – the concentration of insulin given as rabbit units.

(c) Streptozotocin induced diabetes in rats was controlled and cured with camel milk.

(d) Although human, cow and goat milk contain insulin, it is degraded in the acid environment of the stomach. This does not occur with camel milk which does not react to acid (Abu-Lehiya, 1989) and no coagulum is formed. Personal observation in a calf which died 2 hours after suckling: no coagulum was present in stomach although it was filled with milk.

PROTECTIVE PROTEINS:

Camel milk contains various protective proteins, mainly enzymes which exert antibacterial and immunological properties (Kappeler, 1998).
The presence of these proteins help explain some of the **NATURAL HEALING** properties of the milk. The known protective proteins, and their immunological action, in camel milk are:

Lysozymes

- participates in primary immune system, which is based on targeting of structures common to invading pathogens.

Immunoglobulins

- These give the immune protection to the body against infections.

Lactoferrin

- iron-saturated lactoferrin (from second week lactation) prevents microbial growth in gut.
- participates in primary immune system, which is based on targeting of structures common to invading pathogens.
- Camelid milk apparently contains much more lactoferrin than in ruminant (cow, sheep and goat) milk (Morin et al, 1995).

Lactoperoxidase

- lactoperoxidase is found in milk, tears and saliva. It contributes to the non-immune host defense system.
- exerting bactericidal activity, mainly on gram-negative bacteria.
- has growth promotion activity.
- has anti-tumor activity (Ueda et al, 1997).
- has a close relation (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of the thyroid hormones.

Peptidoglycan recognition protein (PGRP)

- the highest concentrations of this enzyme is in camel milk.
- was first discovered in camel milk
- has apparent effect on breast cancer (Kiselev et al, 1998) by controlling metastasis (Kustikova et al, 1996).
- stimulates the host's immune response
- broad antimicrobial activity.

N-acetyl-§-glucosaminidase (NAGase): The milk enzyme NAGase is an accepted test for mastitis in cows. When it was first documented that camel milk was rich in NAGase it was assumed that those camels suffered from subclinical mastitis (Abdurahman, 1995). However after checking milk of hundreds of camels (Chaffer et al, in Press) and llamas (Morin et al, 1995) all with high NAGase levels another conclusion was reached. It was concluded that NAGase has an antibacterial activity and so strengthens the antibacterial-antiviral activity of the milk. It is noteworthy that the NAGase activity is similar to that in women's milk, confirming the nutritional advantages of camel milk over cow milk.
In Israel (RY) a number of diseases have reacted positively to drinking camel milk:

CLINICAL OBSERVATION DATA BASE:

☑ Insulin Dependent Diabetes Mellitus (IDDM):

In India a comparison between conventionally treated juvenile diabetes with those also drinking camel milk showed that the group drinking the milk had significantly reduced blood sugar and reduced HbA1C levels (Agrawal et al, 2002).

The amounts of injected insulin were also significantly reduced.

In Israel diabetics drinking camel milk showed similar results as in the clinical trials. A case in particular was a young girl who started drinking camel milk within 2 weeks of the diagnosis of IDDM. After 8 weeks she was getting minimal dose of insulin while blood sugar declined to 80mg% and HbA1C to 7.

IT IS NOTEWORTHY THAT HYPOGLYCEMIA IS A COMMON FINDING WITH THE MILK, PROBABLY DUE TO THE REDUCED FEEDBACK OF GLYCOGEN.

☑ Milk allergies:

The fact that camel milk lacks lack β–lactoglobulin and a "new" β–-casein (Beg et al, 1986), two powerful allergens in cow milk, makes the milk attractive for children suffering from milk allergies (Makinen-Kijunen & Palosvo, 1992).

Phylogenetic differences could be responsible for the failed recognition of

camels' proteins by circulating IgEs and monoclonal antibodies (Restani et al, 1999). Children with severe food allergies improved rapidly with camel milk.

☑ **Crohn's Disease:** Crohn's disease is becoming an epidemic in many countries. Lately increasing evidence points to a primary bacterial infection by Mycobacterium avium - subspecies: paratuberculosis (MAP). This mycobacterium could spread via cow milk as it is unaffected by pasteurization.

IT IS POSIBLE TO GET MORE INFORMATION FROM THE INTERNET BY SEARCHING "PARATUBERCULOSIS".

Apparently MAP enters the mucosa as saprophytes and only become active when the person is in severe stress, **leading to a secondary autoimmune response**.

As the bacteria belongs to the family of tuberculosis and as camel milk has been used to treat tuberculosis (**Urazakov** & Bainazarov, 1974,) it becomes apparent that the powerful bactericide properties of camel milk combined with PGRP have a quick and positive effect on the healing process. In addition, immunoglobulins attack the anti-DNA and restore the immune system.

☑ **Autism**: As a malfunction of the immune system causes an alimentary enzyme inhibition, causing the breakdown of casein, not to aminoacids, but to **casomorphine**. The casomorphine is a powerful opioid, much more potent than morphine itself. Autistic children drinking camel milk have had amazing improvements in their behavior and diets.

CONCLUSION:

Camels' immune system is stronger than that of humans' and the small immunoglobulins pass from the camel milk into the human blood. As immunoglobulins are found in camel milk throughout lactation, drinking milk will provide a 'tool' for combatting autoimmune diseases by rehabilitating the immune system rather than is depression.

NOTE: Camel milk creams have a healing effect on skin autoimmune diseases.

BIBLIOGRAPHY:

Abu-Lehiya, I.H. (1987). Composition of camel milk. Milchwissenschaf 42: 368-371.

Agarwal, R.P., Swami, S.C., Kothari, D.K., Sahani, M.S., Tuteja, F.C. & Ghouri, S.K. Camel milk as an alternative therapy in Type 1 Diabetes: A randomized controlled trial. Endocrinology/Metabolism: diabetes mellitus 28: 2002.

Alwan, A.A.& Tarhuni, A.H. The effect of camel milk on Mycobacterium tuberculosis in man. In: Proc. 2nd Intl.Camelid Conf. Agro-economics of Camelid Farming. Almaty, September, 2000. p.100.

Barbour, E.K., Nabbut, N.H., Frederichs, W.M.& Al-Nakhli, H.M. (1984). Inhibition of pathogenic bacteria by camels' milk: relation to whey lysozyme and stage of lactation. J. Food Protection. 47: 838-840.

Beg, O.U., von-Bahr-Lindststrom, H., Zaidi, Z.H. & Jornvall, H. (1986). Characterisation of camel milk protein rich proline identifies a new beta casein fragment. Regulatory Peptide. 15: 55-62.

Dodds W.J. (1992). Unraveling the autoimmune mystery. Dog World, 77 (5): 4448.

Dupont, C.and Heyman, M. Food protein-induced enterocilitis syndrome: Laboratory perspectives. J. Pediatric Gastro. Nutr. 30: S50-S57, 2000.

El-Agamy, E.I., Ruppaner, R. Ismail, A., Champagne, C.P. & Assaf, R. (1992). Antibacterial and antiviral activity of camel milk protective proteins. J. Dairy Research. 59: 169-175.

El-Agamy, E.I. Specific immunoglobulins to human rota virus in camel colostrum and milk. In: Proc. 2nd Intl.Camelid Conf. Agro-economics of Camelid Farming. Almaty, September, 2000. p.98.

Farah, Z. 1996). Camel Milk. Properties and Products. SKAT. St. Gallen, Switzerland.

Gorakh, M.D., Sena, D.C., Jain, V.K. & Sahani, M.S. Therapeutic utility of camel milk as nutritional supplement against multiple drug resistant patients. In: Proc. 2nd Intl.Camelid Conf. Agro-economics of Camelid Farming. Almaty, September, 2000. p.99.

Hamers, R. (1998). Immunology of camels and llamas. In: Handbook of Veterinary Immunology. Eds: PP. Pastoret, P. Griebel.& A. Gaevarts. Academic Press, UK. 421-437.

Hamers-Casterman, C. Atarouch, T., Muyldermans, S., Bendolman, N. & Hamers, R. (1993). Naturally occurring antibodies devoid of light chains. Nature. 363: 446-448.

Hoelzer, W., Muyldermans, S. & Wernery, U.(1998) A note on camel IgG antibodies. J. Camel Practice Res.5:187-188.

Kappeler, S. (1998) Compositional and structural analysis of camel milk proteins with emphasis on protective proteins. Ph.D. Diss. ETH No. 12947, Zurich.

Kiselev, S.L. et al (1998) Molecular cloning and characterization of the mouse tag-7 gene encoding a novel cytokine. J. Biological Chemistry. 273:18633-18639.

Koehler-Rollefson, I., Mundy, P. and Mathias, E. (2001). A Field Manual of Camel Diseases. ITDG Publ. London, UK. 254pp.

Kustikova, O.S. et al (1996) Cloning of the tag-7 gene expressed in metastatic mouse tumours. Russian J. Genetics. 32: 540-546.

Makinen-Kijunen, S. & Palosne, T. (1992) A sensitive enzyme-linked immunosorbent assay for determination of bovine beta-lactoglobulin in infant feeding formulas and human milk. Allergy. 47: 347-352.

Martin, F., Volpari, C., Steinkuhler, C., Dimas, N. et al. (1997). Affinity selection of a camelized V (H) domain antibody inhibitor of hepatitis Cvirus NS3 protease. Protein Engineering. 10: 607-614.

Morin, D.E., Rowan, L.L. & Hurley, W.L. (1995). Comparative study of proteins, peroxidase activity and N-acetyl-§-glucosaminidase activity in llama milk. Small Ruminant Research. 17: 255-261.

Muyldermans, S., Cambillau, C. and Wyns, L. (2001). Recognition of antigens by single-domain antibody fractions: the superfluous luxury of paired domains. Trends in Biochem. Sci. 26: 230-235.

Muyldermans, S. and Lauwereys, M. (1999). Unique single-domain antigen binding fragments derived from naturally occurring camel heavy chain antibodies. J. Molec. Recognition. 12: 131-140.

Restani P, Gaiaschi A, Plebani A, Beretta B, Cavagni G, Fiocchi A, Poiesi C, Velona T, Ugazio AG, & Galli CL. Cross-reactivity between milk proteins from different animal species. Clin. Exp. Allergy. 29:997 1004,1999.

Riechmann, L. and Muyldermans, S. (1999). Single-domain antibodies: comparison of camel V H and camelised human V H domains. J. Immun. Methods. (Review) 231: - 25-38.

Sharmanov, T.S.Kadyrova, R.K., Shlygina, O.E. & Zhaksylykova, R.D.(1978) Changes in the indicators of radioactive isotope studies of the liver of patients with chronic hepatitis during treatment with wholecamels' and mares' milk. Voprosy Pitaniya. 1: 9-13.

Ueda, T., Sakamaki, K., Kuroki, T., Yano, I.& Nagata, S. (1997) Molecular cloning and characterization of the chromosomal gene for human lactoperoxidase. Europ. J. Biochem. 243: 32-41.

Urazakov, N.U. & Bainazarov, S.H. (1974) The 1st clinic in history for the treatment of pulmonary tuberculosis with camel's sour milk. Probl. Tuberk. 2:89-90.

Yagil, R. Camels and Camel Milk. Invited publication from FAO (Food and Agricultural Organization of the UN) No. 26. 69pp, 1982.

Yagil R (1985) The Desert Camel: Comparative Physiology. Comparative Animal Nutrition, Vol 5: Karger Ag., Basel, Switzerland. 163pp.

Yagil, R. Camel milk - A Review (invited paper). Int. J. Anim. Sci. 2: 81-89, 1987.

Yagil R, Zagorski, O, van Creveld, C & Saran, A. (1998). Science and camels' milk production. In: Dromedaries and Camels, Milking Animals. Ed. P. Bonnett. Montpelier, France, CIRAD, p- 79-86.

Yagil, R. & van Creveld, C.(2000). Medicinal use of camel milk. Fact or Fancy? In: Proc. 2nd Intl.Camelid Conf.Agro-economics of Camelid Farming. Almaty. September 2000, p.80.

Zagorski, O., Maman, A., Yaffe, A., Meisles, A., van Creveld, C. & Yagil, R. (1998) Insulin in milk – a comparative study. Int. J. Animal Sci. 13: 241-244.

Zhangabilov, A.K, Bekishov, A.A.C. & Mamirova, Y.N.(2000) Medicinal properties of camel milk and shubat. In: Proc. 2nd Intl.Camelid Conf. Agro-economics of Camelid Farming. Almaty, September 2000, p.100.

Table 1: COMPARISON BETWEEN MILK COMPOSITIONS.

	WATER (%)	FAT (%)	PROTEIN (%)	LACTOSE (%)	SODIUM meq/l	CALCIUM (mg%)
HUMAN*	87	3.8	1.2	7	7	34
COWS*	87.3	3.5	3.4	4.8	22	130
CAMELS**	86-91	1.9-2.2	2.8-3.6	2.8-4.2	11.4	80

* Lawrence, 1980 ** Yagil, 1994; Ould, E. & Ramet, 1996.