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EFFECT OF YOGURT MADE FROM CAMEL'S MILK ON IMMUNE RESPONSE

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ABSTRACT

Aging is associated with altered regulation of the immune system. Age–related functional changes were reported for both humoral and cell–mediated immune responses. The food industry could design and construct functional foods with probiotics targeting semi-healthy state of the body as a preventive measure against diseases. Camel milk is one of the important sources of food and can be used for making various dairy products such as butter, cheese and yogurt. The aim of this work was to study the effect of camel milk and yogurt made from mixed camel and cow milks in different ratios on some aspects of innate and adaptive immune functions which showed to be declined with aging.

A total of 42 Sprague-Dawley female rats were obtained. 6 rats weighing 110 to 120 g considered as control young and the rest of rats weighing 260 to 275 g considered as aged rats. The rats were divided into 7 groups, each group contained 6 rats. Rats were fed on raw camel milk, raw cow milk, yogurt made from 40% camel milk + 60% cow milk, yogurt made from 50% camel milk + 50% cow milk and yogurt made from 60% camel milk + 40% cow milk at doses of 2 mL for each rat once daily by stomach tube. Blood samples were taken from each rat and tested for parameters of innate and adaptive immunity including differential white blood cells composition, IgM and IgG levels. Glutathione reduced (GSH), hemoglobin concentration, hematocrit counts, AST and ALT activities were also studied.

Aging caused significant deterioration in both types of innate and adaptive immune functions compared with control young rats.

Feeding on raw camel milk and yogurt samples made from camel and cow milks mixed in different ratios resulted in significant improvement in parameters of innate and adaptive immunity in aged rats. A significant increase in IgM and IgG was observed, while percentages of total circulating white blood cells composition were significantly increased. Feeding on camel milk and yogurt caused significant increase in glutathione level which indicated an improvement in the antioxidant status that have been reduced in aged rats. The highest increase in those parameters was achieved by feeding aged rats on yogurt made from 60% camel milk + 40% cow milk.

We recommend that raw camel milk and yogurt made from camel milk should be incorporated into elderly and aged foods because of its benefical effects on retarded immune functions observed in those populations.

Key words: Innate and adaptive immunity; Glutathione reduced; Camel milk, Yogurt; Aging.

INTRODUCTION

Several studies indicate that nearly every component of the immune system undergoes dramatic age–associated remodeling, leading to changes that include enhanced as well as diminished functions. Consequently, the incidence of severe infections is high and the protective effect of vaccination is low in the elderly. Changes have been described in humoral, cell-mediated and innate immunity (Linton and Dorshkind, 2004 and Plackett *et al.* 2004).

In general, providing extra energy, multiple micronutrients or moderately large doeses of single nutrients improves immune function and thus nutrition is regarded as an important determinant of the immune response. Protein–energy malnutrition is accepted as a major cause of immunodeficiency worldwide and the immune response is considered integral to the pathophysiology of many chronic diseases in which diet plays a major role in prevention or treatment. Several nutritional supplements have been studied aimed at reducing the risk of infection and improving the recovery of immune function during aging. (Romagnani, 1994 and Chandra, 1997).

Food Agriculture organization (FAO) has reported that more than 18 million camels around the world support the survival of millions of peoples. These camels produced 5.4 million tons of milk

every year and a 10 billion $ world market sales (FAO, 2003). Generally, camel`s milk is red-like white, sweet and acrid. It can be salty sometimes or can taste like water.

Camel milk is different from other ruminant milk having low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamins C, B2, A and E, low protein and large concentrations of insulin. Camel milk contains ten times more iron than cow milk and the vitamin C levels are three times that of cow milk and one and a half times that of human milk. There are no allergens and it can be consumed by lactase deficient persons and those with weak immune systems. The value of camel milk is to be found in the high concentrations of volatile acids especially, linoleic acid and poly-unsaturated acids, which are essential for human nutrition (Singh, 2001).

Camel milk having medicinal properties. A series of metabolic and autoimmune diseases are successfully being treated with camel milk. It is used therapeutically against dropsy, jaundice, problems of the spleen, tuberculosis, asthma, anemia, piles and diabetes (Mal *et al.* 2001a). The milk is said to be of such strength, and to have such health– giving properties, that all the bacteria are driven from the body. This action of camel milk may put less pressure on the immune system of the body, which in turn may improve the other functions of the body.

Camel milk contains protective proteins. Among the milk proteins, lactoferrin, immunoglobulin G, lactoperoxidase, lysozyme and some peptides are the main components, which may have a possible role for enhancing the immune defense mechanism (El–Agamy *et al.* 1992). The mean values of lactoferrin and immunoglobulin G concentrations in raw camel`s milk were 0.229 ± 0.135 mg/ml and 0.718 ± 0.330 mg/ml, respectively. The values were slightly higher than those reported in cow`s milk (Konuspayeva *et al.* 2007).

Unlike human immunoglobulins, which have a more complex structure, with two light chains bound to the heavier Y-shaped main chain, camel immunoglobulins have only the main Y-shaped heavy chain, without these additional parts. Camel immunoglobulins are better suited to enzyme inhibitors than human antibody fragments. The camel`s antibodies find it easier to penetrate enzyme active sites than other animal`s antibodies. Larger antibodies cannot reach their

lemet targets, the camel`s antibodies have the same antigen as human antibodies but are ten times smaller that can easily enter the blood stream via the intestines. This, and the relatively small size and weight of the immunoglobulin molecule, offers great potential on immune function because camel immunoglobulin could be used to neutralize viral enzymes. The immunity components found in camel`s milk have proved effective in killing microbial diseases, both viral and bacterial and proved to fortify the immunity system (Hamers-Casterman *et al.* 1993; Riechmann and Muyldermans, 1999 and Jassim and Naji, 2001).

Hashim *et al.* (2009), formulated camel milk yogurts with gelatin, alginate and calcium. Consumer results indicated that the hedonic ratings of the sensory attributes and acceptability of camel milk yogurt containing 0.75% alginate + 0.075% calcium were similar to that of cow`s milk yogurt. Addition of 0.75% alginate + 0.075% calcium could be used to produce acceptable plain or flavored with different fruit concentrates camel milk yogurt.

The aim of this study is to make yogurt from camel milk mixed with cow milk in different ratios and study its effect in comparison with raw camel and cow milks on some parameters of innate and adaptive immune functions, which reduced with aging in rats, to find out the better ratio of yogurt or the best raw milks for improving immune response in aged rats.

MATERIALS AND METHODS

Materials: Raw camel and cow milks were purchased from local market of Giza Governorate, Egypt.

Preparation of yogurt: The process of making yogurt involves culturing milk with live and active bacterial cultures, this is accomplished by adding bacteria directly to the milk. Commercially made yogurt is usually made with a culture of *Lactobacillus acidophilus* and *Streptococcus thermophilis*. Three yogurt samples were made from 40:60%, 50:50% and 60:40% camel milk + cow milk, respectively.

Animals and experimental diets: A total of 42 Sprague–Dawley female rats were obtained from Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. 6 rats weighing 110 to 120 g considered as control young and the rest of rats weighing 260 to 275

g considered as aged rats were housed in plastic cages and fed on basal diet and water for one week as an adaptation period. The basal diet composed of casein (15%), cellulose (5%), vitamins mixture (1%), salts mixture (4%), corn oil (10%) and corn starch (65%). The ingredients of basal diet formulation were performed according to Zamora *et al.* (1991)**.** The rats were divided into 7 groups, each group contained 6 rats. The first group weighing 110 to 120 g fed on basal diet and considered as a control young group. The second group fed on basal diet and considered as a control aged rats. The third and fourth groups were fed on basal diet and administred 2 mL of raw camel milk and cow milk, respectively, for each rat. The other three groups administred yogurt samples made from 40% camel milk + 60% cow milk, 50% camel milk + 50% cow milk and 60% camel milk + 40% cow milk, respectively, at doses of 2 mL for each rat once daily using a stomach tube before meal. Blood samples of rats were taken from orbital plexus venous by using fine capillary glass tubes. Blood samples were allowed to clot for one min., at 37ºC, centrifuged at 1500 xg for 10min., and the separated serum was kept frozen at -20ºC until analysis.

Biochemical analysis: Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activites were colorimeterically determined according to the method of Bergmeyer and Harder (1986). The activity of serum glutathione reduced (GSH) was measured colorimetrically according to the method described by Saville (1958). Blood hemoglobin and hematocrit counts were measured according to Dacie and Lewis (1984).

Immunological tests: A complete and differential white blood cells composition was performed on the EDTA–treated blood by using a Serono Baker Automated System (model 9000 Diff, Allentown, PA). Serum samples for measurement of antigen–specific IgM and IgG titers were prepared and analyzed by an immulon 4 enzyme-linked immunosorbent assay (ELISA) kits (Dynex Technologies, Inc., Chantilly) as described by Deisenhammer *et al.* (1996).

Statistical analysis: The standard analysis of variance procedure in a completely randomized desgin was applied for the present data according to Gomez and Gomez (1984). Least significant difference (LSD) test was done to compare a pair of group means. The level of statistical significance was set at $P<0.05$.

RESULTS AND DISCUSSION

Data presented in Table (1) show the effect of raw camel and cow milks and yogurt samples made from camel and cow milks in different ratios on body weight in aged rats from zero time to the end of the experiment (30 days). Body weight was recorded at three intervals at zero time, after 15 days and at the end of the experiment. Body weight of control young rats was not significantly different during the experimental period, but it was significantly different compared with body weight of control aged rats at zero time and also during the experimental period. Body weight of control aged rats for all groups at zero time was not significantly different and during the three time intervals. There was a significant gradual decrease in body weight for all treatment groups from zero time to the end of experiment. The reduction in body weight was 11.53%, 10.74%, 12.50%, 14.16% and 15.94% for rats fed on raw camel milk, raw cow milk, yogurt made from 40% camel milk + 60% cow milk, yogurt made from 50% camel milk + 50% cow milk and yogurt made from 60% camel milk + 40% cow milk, respectively. These results indicate that increasing the ratio of camel milk in yogurt caused much effective weight loss which considered benefical for immune system enhancement.

Table (1): Effect of raw camel and cow milks and yogurt samples on body weight in aged rats.

Groups	Body weight (g)		
	At zero time	After 15 days	At the end
Control young rats	A 111.20	A 113.33	A 118.33
Control aged rats	B 268.66	B 266.66	B 263.66
Raw camel milk	B 270.39	C 251.31	D 233.25
Raw cow milk	B 269.33	C 250.43	D 235.33
Yogurt (40%camel+60%cow)	B 268.20	C 245.62	D 230.69
Yogurt (50%camel+50%cow)	B 264.65	C 240.33	D 226.33
Yogurt (60%camel+40%cow)	B 266.33	C 238.35	D 221.63
L.S.D.	10.73	13.40	13.77

L.S.D. for interaction between time and treatments= 8.40

A nutritional intervention that has been demonstrated to enhance immune response is caloric restriction. It could be suggested that the immunoenhancing effect may be through energy restriction. The benefical effects of energy restriction on immune response has been observed with an 18% decline in body weight (Umezawa *et al.* 1990).

Aging resulted in a significant decrease in body weight as reported by Albert and Marshall (2008), who found that aged mice developed more severe colitis than other groups as indicated by histological examination and overall weight loss.

Agrawal *et al.* (2002) observed a significant improvement in mean body mass index in patients of type I–diabetes after three months of camel milk treatment. The positive effects in weight gain may be because of good nutritional value of camel milk.

The most important antioxidant to the longevity of any cell is the antioxidant enzyme called glutathione. Without adequate glutathione protection, cells die. It is also a key antioxidant that powers the immune response, especially against viral infection. It has been shown to boost T cell activity and to prevent viral replication (Packer *et al.* 1994). Table (2) represents the effect of raw camel and cow milks and yogurt samples on glutathione reduced levels and liver enzymes activities in aged rats. Blood glutathione reduced levels were significantly decreased in aged rats compared with control young rats at zero time and during the experimental period. The decrease in GSH reached 31.56% at the end of experiment compared with control young rats as a result of aging. GSH levels of control aged rats for all groups at zero time were not significantly different. Administring aged rats raw camel milk, raw cow milk, yogurt made from 40% camel milk + 60% cow milk, yogurt made from 50% camel milk + 50% cow milk and yogurt made from 60% camel milk + 40% cow milk caused a significant increase in GSH levels in blood and the increase reached 22.77%, 20.96%, 29.04%, 30.44% and 45.66%, respectively, compared with control aged rats at the end of the experiment. Yogurt sample made from 60% camel milk + 40% cow milk achieved the highest increase in GSH levels compared with other dietary treatments followed by yogurt made from 50% camel milk + 50% cow milk.

Table (2): Effect of raw camel and cow milks and yogurt samples on glutathione reduced levels and liver enzymes activities in aged rats.

Groups	Glutathione levels (nmol/ml)		AST (IU/L)		ALT (IU/L)	
	At zero time	At the end	At zero time	At the end	At zero time	At the end
Control young rats	A 38.37	A 39.45	B 22.30	B 22.93	E 18.64	E 19.44
Control aged rats	B 27.63	B 27.00	A 28.00	A 30.15	A 24.33	A 24.60
Raw camel milk	B 27.44	C 33.15	A 28.33	B 22.37	A 24.00	E 18.66
Raw cow milk	B 27.74	C 32.66	A 28.67	B 21.40	A 23.74	E 18.20
Yogurt (40%camel+60%cow)	B 27.20	C 34.84	A 29.44	B 22.88	A 24.14	E 18.93
Yogurt (50%camel+50%cow)	B 27.50	C 35.22	A 29.74	B 23.34	A 23.83	E 19.33
Yogurt (60%camel+40%cow)	B 27.83	D 39.33	A 28.73	B 23.80	A 23.56	E 20.66
L.S.D.	3.07		2.46		2.54	

From Table (2) it was found that aging resulted in a significant increase in liver enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities compared with control young rats at zero time and during the experimental period. Control aged rats were not significantly different for AST and ALT activities at zero time for all groups. Feeding on camel and cow milks and yogurt samples decreased liver enzymes activities to the normal levels found in control young rats and the decrease was not significant compared with control young rats. It was found that patients suffering from chronic hepatitis acquired improved liver functions after drinking camel milk (Sharmanov *et al.* 1978).

One of the hallmarks of aging is a reduced capacity of cellular homeostatic mechanisms that protect the body against a variety of oxidative, toxicological and pathological stresses. Nowhere is this loss more pronounced than in the age-related decline in hepatic glutathione (GSH) levels. Glutathione reduced is the principal low molecular weight thiol antioxidant and the cosubstrate for a variety of antioxidant and anti-xenobiotic (phase II) enzymes. Decline in constitutive GSH levels adversely affects cellular thiol redox balance and potentially leaves the cells susceptible to a number of internal and environmental stresses. Conversely, increasing GSH steady–state

levels and/or its rate of synthesis confers enhanced protection against oxidative insult (Hagen *et al.* 2000a).

The present results were in agreement with the results mentioned by Hagen *et al.* (2002b), who found that there are age–associated changes in GSH levels and GSH biosynthetic capacity. Compared with young rats, old animals exhibited a significant 35% decline in overall GSH concentrations, regardless of redox state. Results show a 53 ± 6% loss in hepatic GSH biosynthetic activity in old compared with young rats. Glutathione steady-state levels also exhibited a similar loss with age with an average of 47 ± 8% lower than that observed in young rats.

Maghraby *et al.* (2005**)** showed that GST levels in serum of mice fed on camel milk were increased with mean values of 0.072, 0.085, 0.166 and 0.200% in camel milk groups compared with the mice fed on basal diet with mean values of 0.070, 0.085, 0.078 and 0.069% before infection by soluble worm antigen and after two, four and six weeks of infection, respectively. There were slight differences on ALT and AST activities. Mice treated with camel milk (200 microliter/day) showed an immunostimulatory effect by inducing IgG titers against soluble worm antigen preparation compared with control. In conclusion, camel milk showed an immunomodulatory effect in normally healthy mice by inducing IgG and GST levels before and after infection.

Al–Hashem *et al.* (2009) reported that there was a significant decrease in GSH concentration and an increase in AST and ALT activities in cadmium chloride treated rats compared with control rats. Administration of camel's milk tended to bring the GSH levels to normal levels found in control rats and produced a significant decrease in the levels of AST and ALT in relation to rats received cadmium chloride alone.

Table (3) shows the effect of raw camel and cow milks and yogurt samples on hemoglobin concentration, white blood cells concentration and platelets count in aged rats. Hemoglobin concentration, white blood cells concentration and platelets count were significantly decreased in control aged rats at zero time and during the experimental period compared with control young rats. Feeding aged rats on raw camel and cow milks and yogurt samples made from mixed camel and cow milks caused significant increase in hemoglobin concentration, white blood cells concentration and

platelets count compared to control aged rats. Aged rats fed on yogurt samples were not significantly different compared with control young rats for hemoglobin concentration, while there was a significant difference for aged rats fed on raw camel and cow milks. For white blood cells concentration, aged rats fed on yogurt samples were significantly different compared with aged rats fed on raw camel and cow milks and control young rats. Aged rats fed on raw camel and cow milks and yogurt samples were not significantly different for platelets count compared with control young rats. The highest increase in hemoglobin concentration, white blood cells concentration and platelets count was achieved by feeding aged rats on yogurt made from 60% camel milk + 40% cow milk followed by yogurt made from 50% camel milk + 50% cow milk.

Table (3): Effect of raw camel and cow milks and yogurt samples on hemoglobin concentration, white blood cells concentration and platelets count in a rats.

Groups	Hemoglobin concentration(%)		White blood cells concentration(%)		Platelets count	
	At zero time	At the end	At zero time	At the end	At zero time	At the end
Control young rats	A 13.04	A 13.35	A 8.54	A 8.86	A 630.67	A 694.66
Control aged rats	B 11.33	B 11.30	B 7.23	B 7.10	B 490.34	B 438.45
Raw camel milk	B 11.12	C 12.28	B 7.36	C 10.66	B 455.26	A 634.66
Raw cow milk	B 11.33	C 12.11	B 7.40	C 10.43	B 474.55	A 629.00
Yogurt (40%camel+60%cow)	B 11.17	AD 13.27	B 7.45	D 12.55	B 460.63	A 654.20
Yogurt (50%camel+50%cow)	B 11.13	AD 13.47	B 7.34	D 12.69	B 483.20	A 687.50
Yogurt (60%camel+40%cow)	B 11.31	AD 13.66	B 7.18	D 12.93	B 466.44	A 723.16
L.S.D.	0.75		1.03		130.33	

The mechanisms by which chronic synthesis of the red cell pigment heme involve at least two enzymes, a cytoplasm one (delta-aminoleuvinic acid) at the beginning of heme synthesis and a mitochondrial one, ferrochelatase, at the end of heme synthesis. Ferritin is both a very efficient iron trap and a readily an available source of iron for metabolic requirements and for formation of hemoglobin and other heme proteins. The minute concentration of ferritin in serum is an indicator of body storage iron. Liver injury

results in release of relatively enormous amounts of ferritin into plasma, resigning the serum ferritin concentration and serum iron concentration several hundred times (Shibutani *et al.* 2001).

Agrawal *et al.* (2002) found an improvement in hemoglobin concentration from 9.48 ± 1.96% at base line to 9.54 ± 2.1% at the end of three months of drinking camel milk in diabetic patients. Also, Al-Hashem *et al.* (2009) observed significant increase in hemoglobin and albumin levels after administration of camel milk to cadmium chloride treated rats. It was previously reported that camel's milk contained ten times more iron than cow`s milk and this is may be partly responsible for the improvement in hemoglobin concentrations observed after treatment with camel milk.

In humans, studies of nutritional effects on immunity most often concentrate on peripheral blood lymphocytes. Automated peripheral white blood cell counts and cell differentials are routine clinical measures that have been used as parameters of protein–energy malnutrition (Hendricks *et al.* 1995). Data presented in Table (4) show the effect of raw camel and cow milks and yogurt samples on differential white blood cells composition including: basophils, eosinophils, neutrophils, lymphocytes and monocytes in aged rats.

Table (4): Effect of raw camel and cow milks and yogurt samples on differential white blood cells composition in aged rats (%).

Groups	Basophils		Eosinophils		Neutrophils		Lymphocytes		Monocytes	
	Zero	End	Zero	End	Zero	End	Zero	End	Zero	End
Control young rats	A 4.23	A 4.56	A 3.00	A 3.05	A 54.50	A 54.66	A 33.50	A 33.84	A 4.00	A 4.33
Control aged rats	B 3.50	B 3.25	B 2.58	B 2.51	B 52.55	B 52.14	B 32.00	B 31.50	B 3.50	B 3.43
Raw camel milk	B 3.44	A 4.66	B 2.55	A 3.29	B 52.50	C 56.35	B 32.33	C 35.00	B 3.53	A 4.00
Raw cow milk	B 3.36	A 4.33	B 2.57	A 3.19	B 52.10	C 56.22	B 32.45	C 34.83	B 3.46	A 3.97
Yogurt (40%camel+60%cow)	B 3.46	AC 4.93	B 2.54	A 3.36	B 52.16	C 56.66	B 31.50	C 35.50	B 3.55	A 4.15
Yogurt (50%camel+50%cow)	B 3.33	CD 5.37	B 2.52	A 3.50	B 52.53	D 58.43	B 31.57	D 36.47	B 3.52	A 4.50
Yogurt (60%camel+40%cow)	B 3.29	CD 5.54	B 2.50	AC 3.67	B 52.00	D 59.50	B 32.38	D 36.58	B 3.48	AC 4.59
L.S.D.	0.70		0.40		1.54		0.96		0.42	

Feeding aged rats on yogurt made from 60% camel milk + 40% cow milk caused the highest significant increase in total white blood cells composition compared to control aged rats, followed by yogurt made from 50% camel milk + 50% cow milk. White blood cells composition of eosinophils and monocytes were not significantly different for aged rats fed on different dietary treatments compared with control young rats, while feeding aged rats on dietary treatments caused a significant difference and an increase in neutrophils and lymphocytes composition compared with control young rats. Control young rats were significantly different compared with control aged rats for all white blood cells composition because aging resulted in a significant decrease in differential white blood cells composition.

Invading pathogenic bacteria or viruses are captured and killed by phagocytes such as neutrophils and macrophages. The incidence of infections is significantly elevated in the elderly relative to young adults and defective innate immunity including diminished neutrophil and macrophage functions may be partly responsible. There are age–related changes in peripheral blood eosinophil effector functions and eosinophil degranulation in the older human subjects which was significantly decreased (Vazquez–Torres and Fang, 2001 and Sameer *et al.* 2008).

Pathogens that have escaped capture by phagocytes or NK cells are incorporated and processed by professional antigen-presenting cells, which stimulate T cell clones expressing antigen receptors specific for pathogens. Activated antigen–specific T cells secrete various arrays of cytokines necessary for antibody production, and pathogen–specific antibodies play an important role in the exclusion of pathogens invading the air way, intestine and urinary tract. IgG circulating in serum is principally for defense against infection in the upper respiratory tract, while IgM is used as a diagnostic screening antibody for blood porne infectious agents (Daele and Zicot, 2000).

Results recorded in Table (5) showed the effect of raw camel and cow milks and yogurt samples on immunoglobulins in aged rats. Immunoglobulins in aged rats were not significantly changed at zero time or during the experimental period for both IgG and IgM, but immunoglobulins of aged rats were significantly different compared with contol young rats because aging caused a significant increase in both IgG and IgM. Feeding aged rats on dietary treatments caused significant increase in titers of IgG and IgM compared with both

control young and aged rats. The highest values for IgG and IgM were obtained by feeding aged rats on yogurt made from 60% camel milk + 40% cow milk. IgG was increased by 57.85%, 68.56% and 76.18% for aged rats fed on yogurt samples made from mixed camel and cow milks in ratios of 40%, 50% and 60%, respectively, compared with control aged rats at the end of the experiment. On the other hand, IgM was increased by 47.28%, 50.68% and 58.16% for the same samples compared with control aged rats.

Table (5): Effect of raw camel and cow milks and yogurt samples on immunoglobulins in aged rats.

Groups	IgG (ng/ml)		IgM (ng/ml)	
	At zero time	At the end	At zero time	At the end
Control young rats	32.24 A	32.66 A	2.11 A	2.16 A
Control aged rats	34.95 B	35.94 B	2.65 B	2.94 B
Raw camel milk	34.85 B	53.20 C	2.84 B	3.83 C
Raw cow milk	34.67 B	45.43 D	2.75 B	3.42 C
Yogurt (40% camel+60% cow)	34.25 B	56.73 E	2.86 B	4.33 D
Yogurt (50% camel+50% cow)	34.77 B	60.58 F	2.78 B	4.43 D
Yogurt (60% camel+40% cow)	34.15 B	63.32 F	2.69 B	4.65 D
L.S.D.	2.85		0.47	

Mal *et al.* (2003b) fed tuberculosis patients a diet supplemented with raw camel milk at 1kg/day, while control patients were given dairy milk through 10 weeks. They observed an improvement in hemoglobin concentration and decreases in erythrocyte sedimentation rate and total leucocyte count. A 29.52% and 34.41% increase in hemoglobin content was seen in control and patients supplemented with camel milk daily. The body weight revealed an improvement of 3.38% in control group, whereas the improvement was 9.21% in camel milk group. There were non-significant changes in AST, ALT, protein and albumin between the two groups at the end of the trial. The levels of infection as specified by IgG and IgA in the raw camel milk patients group decreased compared to control group. As regards to IgM status, 62.50% patients of camel milk group were found to be negative, however the control group remained positive at the end of

the trial. Increase in the level of IgG was 41.55% and 65.25% in control and raw camel milk patients groups, respectively.

The present results were in a good agreement with the results mentioned by Murciano *et al.* (2006) and Sahar *et al.* (2008) who found that, control serum from aged mice showed a higher IgG than control serum from young mice, probably as a consequence of the increase in the levels of serum immunoglobulins that has been described in elderly subjects. IgG was increased by 48.18%, 55.08% and 49.85% for aged rats fed on raw broccoli, steamed broccoli and raw cauliflower, respectively compared with control aged rats. IgM was increased by 26.90%, 33.95% and 30.40%, respectively for the same materials.

Age-dependent elevations in oxidative stress, resulting from increased production of reactive oxygen species and peroxides, as well as decreased antioxidant capacity, may contribute to the demise of the aging immune system. Supplementing aged animals with antioxidants can reverse many of the age–related deficits in immune function (Miquel, 2001 and De la Fuente, 2002).

The high minerals content (sodium, potassium, iron, zinc, copper and magnesium) as well as a high vitamin C intake may act as antioxidants thereby removing free radicals, which may provide an additional benefit to camel milk. Minerals prevent the oxidation of lipids in the cell membrane, which can reduce oxidative stress affecting immune cells and stimulate cell–mediated immune functions. The milk also has slimming properties. High concentrations of antioxidants and removal of fat from the body may put less pressure on the immune system. (McKenzie *et al.* 1998 and Baumrucker and Erondu 2000).

From the present results it could be observed that, aging caused a significant decrease in body weight, glutathione reduced, blood hemoglobin, white blood cells concentration, platelets count, differential white blood cells composition, IgG, IgM, AST and ALT activities compared with control young rats. Feeding aged rats on camel milk and yogurt made from mixed camel and cow milks in different ratios, e.g., 40%+60%, 50%+50% and 60%+40% of camel and cow milks, respectively caused a significant improvement in the above mentioned parameters compared with control aged rats with the highest improvement achieved by using yogurt made from 60% camel milk + 40% cow milk. Also, feeding on raw camel milk was better

than raw cow milk for improving these parameters. Consumption of raw camel milk and yogurt made from camel milk caused significant enhancement in aspects of innate and adaptive immune functions.

We recommend that raw camel milk and yogurt made from camel milk should be incorporated into elderly and aged foods because of its benefical effects on retarded immune functions observed in those populations.

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تأثير الزبادي المصنع من لبن الجمال على الاستجابة المناعية.

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*قسم الأغذية الخاصة والتغذية-**وحدة بحوث المطبخ التجريبى-معهد بحوث تكنولوجيا الأغذية- مركز البحوث الزراعية- الجيزة.

يرتبط التقدم في السن بتأخر تنظيم عمل الجهاز المناعي والتغير في الوظائف مع كبر السن ظهر في الاستجابات المناعية على مستوى كل من الجسم والخلية. صناعة الأغذية يمكن أن تصمم وتنشئ أغذية وظيفية تحتوى على المدعمات الحيوية والتي تهدف لتعديل الحالة الصحية للجسم كعامل مانع للأمراض. ويعتبر لبن الجمال احد المصادر الغذائية الهامة ويمكن استخدامة لعمل العديد من منتجات الألبان مثل الذبدة والجبن والزبادي. كان الهدف من هذا البحث هو دراسة تأثيرات لبن الجمال والزبادي المصنع من خليط من لبن الجمال والأبقار بنسب مختلفة على بعض الوظائف المناعية لكلا قسمي جهاز المناعة والتي تتدهور بالتقدم في السن.

تم استخدام عدد 42 فار من الإناث وكان عدد 6 من هذة الفئران تزن من 110 إلى 120 جم واعتبرت مجموعة الكونترول صغيرة السن وباقي الفئران كانت تزن من 260 إلى 275 جم واعتبرت مجموعة الفئران كبيرة السن وقسمت إلى 6 مجموعات وتم تغذية هذة المجموعات على لبن الجمال الخام، لبن الأبقار الخام،الزبادي المصنع من خليط من لبن الجمال والأبقار بثلاث نسب مختلفة هى 40%+60%، 50%+50%، 60%+40% من كل من لبن الجمال والأبقار على التوالي بمعدل 2 مل لكل فار مرة واحدة يوميا باستخدام أنبوبة معدية. وقد تم تجميع عينات الدم من الفئران وتقدير قياسات كل من المناعة الطبيعية وتشمل نسب خلايا كرات الدم البيضاء وعددها وكذلك قياسات المناعة المكتسبة وتشمل الجلوبيولينات المناعية وكذلك تقدير إنزيم الجلوتاثيون ووظائف الكبد.

التقدم في السن أدى إلى تلف ملحوظ في كلا نوعى الوظائف المناعية بالمقارنة مع الفئران الصغيرة السن. أدت التغذية على لبن الجمال الخام والزبادي المصنع من خليط من لبن الجمال والأبقار بنسب مختلفة إلى تحسن ملحوظ في قياسات كل من المناعة الطبيعية والمكتسبة في الفئران كبيرة السن، وقد حدث زيادة معنوية ملحوظة في الجلوبيولينات المناعية بينما نسب تركيب خلايا كرات الدم البيضاء الكلية قد زادت بصورة معنوية ملحوظة. التغذية على لبن الجمال والزبادي سبب زيادة ملحوظة في مستوى إنزيم الجلوتاثيون والذي يعكس تحسن حالة مضادات الأكسدة في الجسم والتي انخفضت مع التقدم في السن بالمقارنة مع الفئران الصغيرة السن. وكانت أعلى زيادة في هذة القياسات السابقة عند تغذية الفئران على الزبادي المصنع من لبن الجمال والأبقار بنسبة 60% لبن جمال و40% لبن أبقار.

من نتائج هذة الدراسة يمكن التوصية بأهمية إضافة لبن الجمال والزبادي المصنع من لبن الجمال في أغذية الكبار والمتقدمين في السن لتأثيراتها وفوائدها الهامة على الوظائف المناعية المتدهورة والتي تلاحظ في هذة الفئات العمرية.