PRODUCTION OF MILK ENRICHED IN OMEGA 3 AND OMEGA 6 CONTENT BY SUPPLEMENTING RATIONS OF LACTATING ANIMALS WITH RUMEN-PROTECTED VEGETABLE OILS

By

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B. Sc. Agric. Sc. (Animal Production), Cairo University, 2002

M. Sc. Agric. Sc. (Animal Nutrition), Ain Shams University, 2008

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ABSTRACT

Ramadan Mohamed Ahmed Abd El Gawad: Production of Milk Enriched in Omega 3 and Omega 6 Content by Supplementing Rations of Lactating Animals with Rumen-Protected Vegetable Oils. Unpublished Ph.D. Thesis, Department of Animal Production, Faculty of Agriculture, Ain Shams University, 2013.

The main objective of this study was to evaluate the effectiveness of new encapsulation method to protect vegetable oils rich in polyunsaturated fatty acids from rumen biohydrogenation. Alginate/carragenan calcium beads were used to encapsulate linseed oil as a source of omega fatty acids. Two concentrations from linseed oil beads (beads 1; 15% and beads 2; 20% oil) were prepared. Encapsulation efficiency was evaluated by measuring the quantity of saved oil by beads and changes on linseed oil fatty acids profile after encapsulation process. In vitro evaluation of linseed oil beads using rumen fluid collected from ruminally fistulated Polish Holstein-Friesian cows within gas production system (GPS), batch culture system (BCS) and rumen simulation technique system (Rustic system) was done. Within GPS, Linseed beads 1 (15% oil), linseed beads 2 (20% oil) and unprotected linseed oil were supplemented to the substrate at four levels (0, 2, 4, and 6%) from substrate as DM basis. The closest level to the control case was the 4% level of linseed oil and linseed oil beads which was supplemented to basal substrates and compared with the unsupplemented basal substrates for in-vitro evaluation using BCS and rustic system. In-vivo evaluation was conducted using fifteen lactating Damascus goats one week after parturition which were equally divided between three treatments (five each). The treatments were, Control (without supplement), P.O (control diet+ 2% protected linseed oil beads containing 15% oil) and O treatment (control diet+ 2% unprotected linseed oil (as dry matter basis)). The results indicated that the saved oil by beads was 86% and 87% for beads 1 and beads 2, respectively. The encapsulation process didn't have a significant negative effect on the fatty acid profile. The overall results from the gas production system trial concluded that beads 1, beads 2 and unprotected linseed oil at different

levels didn’t have a negative effect on fermentation pattern in most cases. The obtained results indicated that the only clear negative effect for linseed oil treatment was on protozoa count which was clear from its values. The closest level for the control case from these three treatments was the 4% which was used in the next experiments. Within batch culture system to evaluate the biohydrogenation process, the results showed that short chain fatty acids wasn’t affected by treatments after both 24 and 48h of incubation whereas medium chain fatty acids were decreased significantly ($P < 0.01$) by treatments than control after 24 and 48 of incubation. Linseed oil treatments, as protected and unprotected, significantly ($P < 0.01$) decreased saturated fatty acids after 24 and 48h of incubation than control. Monounsaturated fatty acids were significantly ($P < 0.01$) increased by linseed oil treatment than other treatments and control after 24 and 48h. Monounsaturated fatty acids in cis form were increased by treatments than control after 24 and 48h of incubation. Monounsaturated fatty acids in trans form were decreased significantly ($P < 0.01$) by both beads form than control and linseed oil treatments. Polyunsaturated fatty acids, omega 3 and omega 6 fatty acids, were increased significantly ($P < 0.01$) by beads 1 and beads 2 than control but not significant than linseed oil treatment after 24 and 48h of incubation. Omega 6/omega 3 ratio was significantly decreased ($P < 0.01$) by all treatments than control after 24 and 48h of incubation. Within long term of incubation using Rustic system, the results indicated that means of pH, oxireductase, over flow, total bacteria count, *Entodinimorpha* protozoa, total gas production, methane production, IVDMD and total and fraction volatile fatty acids were not affected by treatments. However, ammonia concentration and *Holotritcha* protozoa were decreased significantly by linseed oil treatments. Within lactation trial, rumen fermentation parameters were not significantly affected by treatments at different times, except, butyric acid at zero time and acetic acid at 3h after feeding where decreased significantly by linseed oil (O) treatment than control. Dry matter (DM), organic matter (OM), crude protein (CP),ether extract (EE) and nitrogen free extract (NFE) digestibilites were not significantly affected by treatments; however, crude fiber (CF) digestibility was significantly decreased by linseed oil treatment

than protected linseed oil. For Blood parameters, The overall means of blood serum total protein, albumin, globulin, glucose, alanin aminotransfereas (ALT), aspertate aminotransfereas (AST), calcium, total triglyceride and low density lipoprotein cholesterol (LDL) content were not significantly ($P > 0.05$) affected by treatments. However, blood serum urea content was significantly increased ($P < 0.05$) by linseed oil than protected than control. Also, blood serum total cholesterol content was significantly decreased ($P < 0.05$) by protected linseed oil (P.O) than linseed oil (O) but not than control. Blood serum high density lipoprotein cholesterol (HDL) content was significantly increased ($P < 0.05$) by linseed oil (O) than control but not than protected linseed oil (P.O). Milk yield was significantly increased ($P < 0.05$) by 50.5% and 32.2% by linseed oil and protected linseed oil than control, respectively. Milk total solids, total protein, lactose, solids non fat and ash content were not significantly affected by treatments. However, milk fat content was significantly decreased by linseed oil than other treatments. The results of milk fat fatty acids fraction indicated that linoliec acid (C18:2 n6), increased ($P > 0.05$) numerically than control and O treatments. Moreover, linolenic acid (C18:3 n3) was increased by protected linseed oil (P.O) by 14.4 % and 49.4 % than control and linseed oil (O), respectively. The sum of linoliec and linolenic fatty acids (as main polyunsaturated fatty acids in milk fat) was increased significantly ($P < 0.05$) by protected linseed oil than linseed oil treatments but it was insignificant ($P > 0.05$) than control. However, sum of saturated fatty acids (measured within this trial) didn't have a significant difference between treatments, although it decreased numerically by protected linseed oil than linseed oil and control treatments. Finally, omega 6/omega 3 ratio were not significantly ($P > 0.05$) affected by treatments. Generally, the fraction of milk fat fatty acids was modified by treatments towards increasing polyunsaturated fatty acids and decreasing saturated fatty acids, even it was insignificant, by protecting linseed oil. In conclusion, using alginate/carragenan calcium beads succeeded to avoid negative effects of linseed oil on rumen environment and, relatively, protect polyunsaturated fatty acids from rumen