Assessment of protection against ruminal biohydrogenation of different forms of flaxseed

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INTRODUCTION

Nowadays, consumers' demands towards healthier food are increasing. In this sense, and in line with medical recommendations, many consumers tend to buy milk products with a healthier fatty acid profile. Especially, they prefer higher levels of Omega-3, due to the positive effects of these fatty acids in relation to cardiovascular diseases, different types of cancers and neurological health (Abuajah et al., 2014). Consequently, the presence of these fatty acids in milk is of great interest in terms of both human health and farmers' income

In fact, the dairy industry is currently rewarding farmers who produce milk with higher content of Omega-3. It is therefore interesting to provide farmers with elements (raw materials or feed additives) that allow them to take benefit from this situation. Among raw materials, flaxseed has been identified by several authors (Oeffner et al., 2013) as an option to increase the presence of Omega-3 in milk

However, rumen physiology requires this type of fats to be administered in a way that this can be transferred into milk fat. For this, these fats must be protected from ruminal biohydrogenation, in order to make them available to the animal at the intestinal level (Petersen and Jensen, 2014)

OBJECTIVE

The aim of the study was to assess the effect of different forms of presentation of flaxseed on the degree of protection against rumen biohydrogenation of their poliunsaturated fatty acids (Omega-3 included)

MATERIALS AND METHODS

Treatments

Below, the crude fat content and the fatty acid profile are shown:

Main Fatty Acids content and Crude Fat of each treatment					
	Treatments				
Samples	T2: Flax oil	T3: Calcium soap of flax fatty acids	T4: Absorbed flax oil	T5: Extruded linseed	T6: Linseed-stearin
Crude Fat (%)	100	78.4	65.4	25.1	95.2
Fatty acid profile %					
C16:0	8.35	16.31	7.39	13.52	37.57
C18:0	3.9	5.98	3.77	4.25	35.54
C18:1	19.53	29.61	19.87	15.01	6.29
C18:2	16.00	15.75	15.67	18.72	4.51
C18:3	51.66	28.24	52.27	48.51	13.88

Control and experimental diets

Treatments were fermented *in vitro* separately along with the following control diet:

Characteristics of the control diet	
Ingredients	%DM
Corn grain	31.55
Soybean 44%	11.41
Dehydrated alfalfa	34.60
Maize silage	21.62
Premix (Vit-Min)	0.51
$CaCO_3$	0.31
Chemical composition of the diet	
Dry Matter (%)	89.80
Crude Protein (%)	16.82

Once the control diet was added to each treatment, the following experimental diets were obtained:

Characteristics of the experimental diets			
Treatments	Diet (g)	Sample (g/200mL)	% EE
T1 (control diet)	3.00	-	-
T2	3.00	0.2500	8.3
T3	3.00	0.3013	8.3
T4	3.00	0.3846	8.3
T5	3.00	0.9398	8.3
T6	3.00	0.2500	8.3

Laboratory techniques

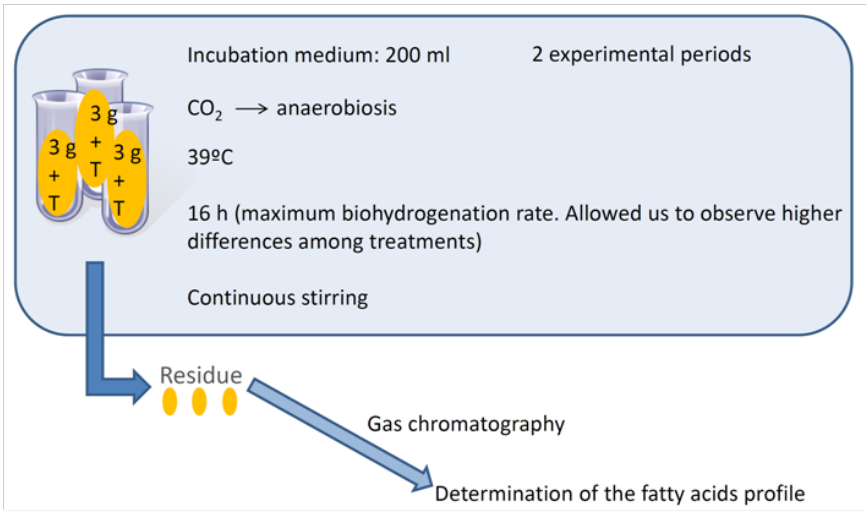
The Tilley-Terry *in vitro* digestibility methodology was used. In the following table, the culture media, the substrate and the different treatments are shown

Ruminal liquid taken from a cannulated cow mixed with a buffer in the ratio 1:1 was used as incubation system. The laboratory tubes were prepared in triplicate for each treatment and two experimental periods were performed

Tilley-Terry *in vitro* digestibility			
Culture media	Substrate	Treatments	
Rumen liquid + buffer (proportion 1:1)	Regular diet for dairy cows	T1	Negative control (it does not contain lipids)
		T2	Flax oil
		T3	Calcium soap of flax fatty acids
		T4	Absorbed flax oil
		T5	Extruded linseed
		T6	Lineseed-stearin

Each incubation tube contained 3 g. of experimental diet plus the corresponding treatment and the culture media (200 ml). To achieve an anaerobic environment, CO2 was infused during the preparation of the media to the incubation tubes containing experimental diets. Incubation was performed in a thermostatic bath at 39 ˚ C. Experimental diets were incubated during 16 hours with continued stirring. The residual content of each tube was weighed to determine the dry matter. Later, they were lyophilized for subsequent determination of the fatty acid profile by gas chromatography

The fermentation process and the determination of the fatty acid profile have been schematized in the following figure



Assessment of the level of protection against ruminal biohydrogenation

Due to the differences among the fatty acid profile of the treatments, the degree of protection (or bypass) of each of them was estimated by means of the following formula:

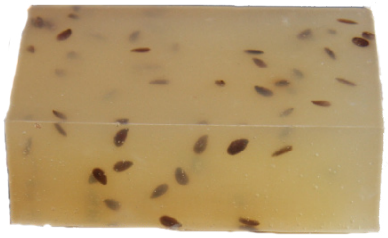
$$\%\ \text{fatty acid protection} = \left(\frac{\text{fatty acid after fermentation (g)}}{\text{fatty acid before fermentation (g)}} \right) x\ 100$$

RESULTS

Finally, we obtained the levels of protection of each fatty acid, which are represented in the following table as the percentage of fatty acid protected from its initial content in each treatment

Fatty Acid	T2	T3	T4	T5	T6
C18:1t11	6.75c	1.71a	11.61d	11.03d	2.29a
C18:1t9	9.25e	11.61f	9.40e	8.06d	4.03b
C18:1c9,12	9.20cd	9.9d	7.68b	9.01c	5.34a
C18:2c10,12	5.04c	3.69b	6.92d	7.63d	1.6a
C18:3c6,9,12	0.21a	1.59b	No detectable	0.6a	0.02a
C18:3c9,12,15	19.88d	10.33b	15.37c	16.82c	8.22b
C18:3 (%)	19.9	18.7	15.2	17.9	30.5
C 18:1 + C18:2	30.24c	26.91b	35.61d	35.73d	12.82a

As it can be observed, differences ($p < 0.0001$) among treatments for the analyzed fatty acids were found. The product with the highest degree of protection against biohydrogenation with respect to C18:3 was lineseed-stearin



CONCLUSION

The use of linseed-stearin is recommended to feed dairy cows in order to produce milk with a higher content of OMEGA-3

PRODUCT DEVELOPMENT

Finally, and taking into account NOREL's infrastructure and expertise, flax fatty acids were protected with hydrogenated fat

REFERENCES

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- *Petersen, M.B., Jensen, S.K. 2014. Biohydrogenation of fatty acids is dependent on plant species and feeding regimen of dairy cows. Journal of Agricultural and Food Chemistry, 62: 3570-3576*