Effects of dietary potassium diformate on feed intake, weight loss and backfat reduction in sows: pre-farrowing till weaning

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Introduction Potassium diformate, a double-salt of formic acid, has been shown in numerous trials to improve health and performance in piglets, growing-finishing pigs and sows. Thus, potassium diformate (KDF) has been approved in the European Union as the only non-antibiotic growth promoter for use in swine. The effect of KDF is often described as strong antimicrobial and digestibility enhancing. Recent regulatory changes have set the minimum dosage guidelines for KDF-usage in sows to 10 kg KDF per ton of feed. The objective of the present study was to assess the effects of KDF on feed intake and condition of crossbred sows at 8 kg per ton feed.

Material and methods The study was carried out on second to fifth-parity crossbred sows (Yorkshire x Landrace) during late pregnancy. The experiment was conducted in Southern Vietnam on two farms. In total, 52 sows (initial weight 203.2 ± 18.0 kg) were used. The sows were randomly allotted to 2 treatment groups. Group 1 served as a control in which sows were fed a complete diet, based on rice, corn and soy, without supplemented antimicrobial agents. Sows of group 2 were fed the complete diet containing 8 kg/t potassium diformate. The experimental feeding of sows started on day 12 prior to farrowing and finished at weaning, which was at 4 weeks post-partum. Body weight and backfat thickness of sows were calculated/measured at the beginning of the experiment, 3 days after farrowing and at weaning. The live weight was calculated with the following formula: body length x (chest circumference)^2 / 14400 (kg) – (Chinh, 2010). The body length was measured as the length from the base of the neck to the base of the tail, while the chest circumference was measured immediately behind the front legs. The thickness of backfat of sows was determined using a Renco Lean Meter Backfat Scanner. Data on feed intake, weight loss as well as backfat thickness reduction from farrowing till weaning were recorded and analysed using the t-test. The results are given as mean ± SD and a confidence level of 95% was defined for these analyses.

Results Sows fed with potassium diformate at a dosage of 8 kg/t under hot and humid conditions showed no difference in feed intake from 12 days prior to farrowing till 3 days after farrowing. However, the feed intake in treated sows tended to be higher ($P<0.1$) from 3 days after farrowing onwards. Furthermore, a reduced weight loss ($P=0.05$) during the weaning period could be monitored. At the same time also the backfat loss tended ($P=0.06$) to be reduced.

Table 1 Diet effects on feed intake, body weight loss and backfat reduction in sows

	Control	8 kg/t KDF	P-level
Initial sow weight [kg]	200.2±17.5	204.2±18.0	0.25
Feed intake till farrowing [kg/pig/d]	2.33±0.14	2.36±0.11	0.41
Feed intake from farrowing [kg/pig/d]	4.64±0.47	5.08±0.30	0.096
Weight loss [kg]	18.7±9.9	13.6±9.1	0.050
Backfat loss [mm]	2.4±1.9	1.5±1.7	0.061

Conclusions These result show that the inclusion of potassium diformate into the diet of sows can improve feed intake and condition. Similar observations have been made by Øverland *et al*. (2009) and in unpublished results from the EU-registration of KDF. It is suggested that also the 8 kg/t inclusion of KDF will still show beneficial effects onto the sow.

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Seasonality and heterogeneity in live fish movements and their implications for Scottish aquaculture

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Introduction Scottish aquaculture produces *c.* 130,000 tonnes of Atlantic salmon (*Salmo salar*) per year, and provides 849 full-time and 100 part-time jobs (Marine Scotland Science, MSS, 2009). Atlantic salmon are anadromous and have fresh-water (FW) and salt-water phase (SW). In fresh water, salmon eggs are fertilized and hatched in a hatchery. Next, fry are transported to fresh-water sites. After approximately one year, the fish (smolts) are moved to marine waters, where they achieve harvest size after approximately eighteen months. Occasionally, salmon are moved during the marine phase. Live fish movements are an important potential route for between-site disease spread, and are related to an increased risk of several diseases. The distribution and timing of these movements can have a big impact on epidemic dynamics as seen with the British foot-and-mouth disease outbreak in 2001 (Gibbens *et al*. 2001). Understanding movements is important in order to develop control strategies for diseases, but so far, limited data are available for salmon. Previous studies have taken into account heterogeneity (Green *et al*., 2009), but not seasonality or heterogeneity stratified per production phase. The aim of this study is to provide a detailed description of the number of live fish movements and their timing for Atlantic salmon in Scottish aquaculture.

Materials and methods Scottish farms are obligated to keep records regarding the live fish movements onto and off their farms. These records contain the source/destination, species, number of fish transported and their development stage (ova, smolt and growers). We collected salmon movement records from 1 January 2002 until 31 December 2004. Only confirmed movements, i.e. movements recorded by both source and destination site, were used. Movements to or from unregistered sites, such as fisheries, could not be validated and were therefore not included in the analysis. Movements between the same pair of sites were often repeated: 40% of all movements re-occurred within a week. These movements were combined and entered as one movement in the dataset.

Results In total, 299 sites had off movements, which varied from 1 to 65 off movements per site (median=4) and 471 sites had movements onto their site, which varied from 1 to 38 on movements per site (median=2). We recorded five different types of movements: FW to FW (N=1185), FW–SW (N=806), SW–SW (N=237), SW–FW (N=54) and 'other' movements (N=119). The latter are mainly movements from and to research farms. These different types of movements vary in the number movements going onto or off their site (Table 1) and in their timing (Figure 1).

Table 1 Number of sources and destinations per site of Scottish salmon sites during 2002-2004.

	FW–FW		FW–SW		SW–SW		SW–FW		Other	
	On	Off	On	Off	On	Off	On	Off	On	Off
Median	5	7	3	4	1	2	3	3	4.5	1
Range	1 to 38	1 to 52	1 to 16	1 to 44	1 to 22	1 to 10	1 to 8	1 to 15	1 to 13	1 to 36

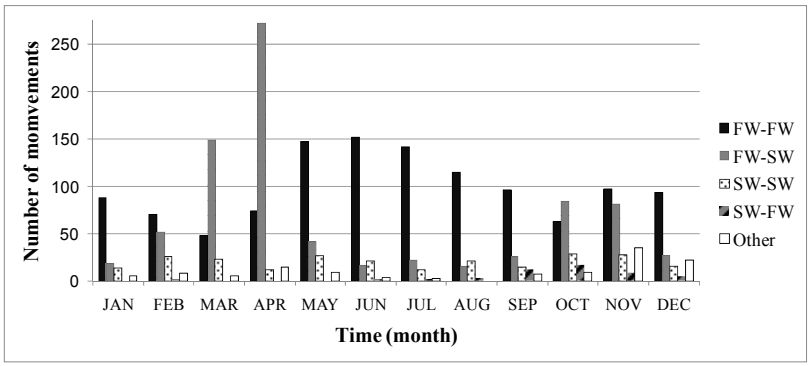

Figure 1 The timing of salmon movements during the study period (2002 to 2004), stratified by source and destination site type (FW = fresh water, SW = salt water).

Conclusions To control and prevent epidemics early identification of infected farms is crucial, especially in periods when many movements occur between sites. For example, FW–SW movements peak from March to May and from October to November, during this time an epidemic can easily develop for diseases that infect both FW and SW salmon, such as infectious pancreatic necrosis. Sites that receive salmon from different sites have an increased risk of infection and should therefore limit the number of sites they provide fish to.

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A study on possibility of using sugar beet molasses in honey bee nutrition

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Introduction Artificial nutrition is required for honey bee colonies in winter and autumn. The aim of artificial nutrition in honey bee is to provide winter food storage and to stimulate queen hatch. The amount of sugar needed for adequate bee colony nutrition is 1kg/colony/y (Batra,1995). The possibility of using sugar beet molasses instead of sugar in honey bee nutrition could reduce the cost of nutrition (Milne, 1985). The aim of this study was to investigate the effects of using sugar beet molasses instead of sugar in honey bee nutrition on reserved honey during rearing period, colony population and the number of egg frames, larvae and pupa.

Material and methods A completely randomized design (CRD) was utilised to study the possibility of using sugar beet molasses instead of sugar in honey bee nutrition. Forty colonies were used in this study. Colonies were randomly allocated to four experimental treatments. The study lasted for 75d (14d for adaptation and 60d for data recording). The experimental treatments were: control diet (without beet molasses, 100% sugar), low beet molasses (LM,10% beet molasses with 90% sugar), medium beet molasses (MM, 20% beet molasses with 80% sugar) and high beet molasses (HM, 30% beet molasses with 70% sugar). The diets were offered once daily (1700h), in a dish feeder. Equipped colonies were visited weekly and colony population, number of egg frames, larvae and pupa were recorded. Deposited honey was weighed at the end of rearing period. Data were analysed by using the MIXED procedure of SAS software.

Results The amount of deposited honey during rearing period, colony population and the number of egg frames, larvae and pupa of colonies are shown in Table 1. The results of analysis of variance indicated that the using sugar beet molasses instead of sugar had no significant effect on reserved honey during rearing period. The colony population, and the number of egg frames, larvae and pupa were decreased significantly ($P<0.05$) as sugar beet molasses was utilised instead of sugar.

Table 1 Reserved honey during rearing period, colony population and number of egg frames, larvae and pupae as affected by diet.

Item	Diet*				SEM	P value
	Control	LM	MM	HM		
Reserved honey during rearing period (kg)	14.8	13.5	12.15	12.3	0.87	NS
Colony population (Number of pan)	9.8^{a}	7.4^{b}	7.1^{b}	7.1^{b}	0.16	0.005
Number of egg frames, larvae and pupa	3.4^{a}	3.1^{ab}	2.7^{bc}	2.3^{c}	0.14	0.006

*Diets: control, LM, MM and HM contained 0, 10, 20 and 30% beet molasses, respectively. Means with different superscripts within a row were significantly different ($P<0.05$).

Conclusions The results revealed that beet molasses, which is a cost-effective by-product, could be used as a replacement for sugar in honey bee nutrition without having an adverse effect on the amounts of reserved honey. However, the use of beet molasses instead of sugar in honey bee nutrition had a negative effect on colony population, and the number of egg frames, larvae and pupa.

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The effect of *Vernonia amygdalina* leaf extract on Alloxan-induced diabetic rats

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Introduction Bitter leaf **(***Vernonia amygdalina***)** plant is commonly found in Nigerian farms and forests lands and used locally as a soup especially for recuperating patients. It is often speculated to possess anti-diabetic properties. The hypoglycaemic or sugar reducing effect of the Bitter Leaf Extract (BLE) was determined using Alloxan-induced diabetic rats.

Material and methods Thirty male Albino rats were divided into six groups of five rats. Four groups with basal blood sugar levels of 38.0±0.16, 39.2±.23, 35.2± 0.27and 35.8± 0.25 mg/dl were injected with 10% alloxan in saline to make them diabetic (277.6±6.55, 284.8±3.80, 256.4±1.39 and 265.6±4.41mg/dl Fasting Blood Sugar (FBS) respectively). The 4 diabetic groups were then treated with different doses (g/kg body weight, BW) of an aqueous extract of dried bitter leaf herein referred to as BLE. A fifth group (non diabetic) was treated with 400mg BLE /kg BW. BLE was administered twice daily for 2weeks using an oral cannula. The sixth group (non-diabetic) received no BLE as a positive control. Blood was collected from the tail to determine blood on a glucometer. The FBS levels of the six albino rat groups were recorded every 2 days for 2 weeks. At the end of week 2, the rats were slaughtered and their liver, kidney and pancreas were examined histologically to ascertain if BLE was toxic to the organs or not. Data were analysed using ANOVA (SAS, 1999).

Results All the rats injected with alloxan became diabetic as their fasting blood sugar (FBS) levels exceeded the normal range of between 80 – 100 mg/dl. The FBS of the diabetic albino rats significantly ($P<0.05$) decreased as BLE levels increased from 50 to 400mg/kg BW on days 2, 4, 6, 8, 10, 12 and 14 (Table 1). The plant extract was observed to have a hypoglycaemic effect on each group of diabetic rats as it reduced FBS levels (mg/dl) from 277.6 ± 6.55 to 92.0 ± 1.68 (Group 1), 284.8± 3.80 to 68.8±0.41 (Group 2), 256.4 ± 1.39 to 55.8±0.49 (Group 3) and 265.6 ± 4.41 to 38.4±0.21 (Group 4) over a period of two weeks. Administration of BLE at the concentration (mg/kg) of 200, 400 and 400 to albino rats in groups 3, 4 and 5 respectively beyond day 12, 8 and 4 elicited hypoglycaemic effect or low blood sugar below the normal glycaemia/ blood sugar level of 60 – 104.4 mg/dl (Wikipedia, 2011). The fasted blood sugar level of rats in group 5 and 4 compared with that of group 6 after day 8 and day 12 respectively. Phytochemical screening of the leaves of *Vernonia amygdalina* revealed the presence of alkaloids, tannins, saponins and cardiac glycosides. The plant extract had no adverse effect when administered on normal rats except for a marked congestion of the mesenteric blood vessel. The extract reduced the level of damage to the kidney, liver and pancreas when administered to diabetic rats. The rats were considered treated when their FBS returned to almost their Basal Blood Sugar (BBS) levels especially those in group 4 in two weeks. Albino rats in group 4 got treated quickly as compared to other induced diabetic rats probably because of the higher dose of BLE administered (i.e. 400mg/kg).

Table 1 Fasting blood sugar (mg/dl) of normal and induced-diabetic albino rats administered with varying doses of *Vernonia amygdalina* leaf extracts.

Number of Days	Group 1 50mg/kg	Group 2 100mg/kg	Group 3 200mg/kg	Group 4 400mg/kg	Group 5 400mg/kg	Group 6 Control	SEM
2	237.4±5.22^{a}	226.6±1.76^{b}	203.2±0.62^{c}	201.8±3.20^{c}	65.6±0.43^{d}	54.4±0.54^{e}	2.11
4	231.2±5.27^{a}	200.0±1.94^{b}	151.6±0.95^{c}	94.0±0.83^{d}	60.0±0.38^{e}	46.0±0.26^{f}	2.09
6	196.0±4.57^{a}	176.0±1.97^{b}	94.0±0.73^{c}	72.0±0.62^{d}	55.0±0.45^{e}	44.0±0.37^{f}	1.34
8	163.4±4.01^{a}	132.0±1.21^{b}	89.0±0.58^{c}	62.0±0.65^{d}	47.6±0.36^{e}	41.8±0.22^{f}	1.60
10	142.2±3.34^{a}	102.0±0.88^{b}	75.0±0.55^{c}	50.8±0.32^{d}	42.2±0.23^{e}	41.2±0.21^{e}	1.50
12	110.4±1.93^{a}	80.0±0.63^{b}	61.0±0.57^{c}	44.0±0.39^{d}	42.2±0.24^{de}	40.0±0.21^{e}	1.71
14	92.0±1.68^{a}	68.8±0.41^{b}	55.8±0.49^{c}	38.4±0.21^{d}	38.0±0.22^{d}	40.0±0.23^{d}	1.62

Conclusion *Vernonia amygdalina* has anti-diabetic properties as it reduced the blood sugar level of albino rats.

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Carcasses of Belgian Blue culled cows and growing fattening bulls : 1 characteristics of the cuts

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Introduction Beef meat in Belgium is produced mainly from Belgian Blue culled cows and growing fattening bulls. All these animals are characterized by an extremely large muscle development so that carcasses are processed by butchers or in meat plants according to specific anatomical cuts. The aim of the study was to compare the characteristics of the carcasses and the cuts of culled cows and fattening bulls of the Belgian Blue breed fattened in similar conditions.

Materials and methods Thirty two culled cows and 20 growing fattening bulls were fattened with a similar concentrate sugar beet pulp based diet. Three days after slaughter the carcasses were processed at the meat plant with the cutting technique used in Belgium for the double muscled cattle. The technique is carried out on a muscle or anatomical basis rather than with cuts on large meat pieces as commonly practiced with cattle. The cuts were divided in 10 major groups according to culinary purposes. The 6 most valuable groups of cuts were fillet, top loin cuts, 1st class steaks, roasts cooked on dry heat methods, roasts cooked on moist heat and tenderized cuts for second class steaks. Very lean cuts or sub cuts were used to produce ground beef and stew. There were also cuts for boiled meat. The small pieces and the trimmings were processed as minced meat. The weights of all the pieces, of fat and of meatless bones were recorded.

Results The age at the end of the fattening was 68.6 months for the cows and 20.3 months for the bulls. The slaughter weights were 722 and 542 kg (P<0.001) for the cows and the bulls respectively. The corresponding cold carcass weights and killing out percentages were 448 and 362 kg (P<0.001) and 63.5 and 68.5% (P<0.001). The weights of the different groups of pieces in half carcasses are given in Table 1. The weight of all the pieces was larger in the cow carcasses than in the male carcasses, most of the differences being significant except for the second class steaks, the lean ground beef and the stew. That was expected owing to the larger slaughter weights with the females. The proportions of the different classes were calculated on the basis of the total weights. All the proportions were significantly higher with the bulls than with the females except for the top loin, minced meat, fat and meatless bones. The differences between the carcasses of the 2 types of animals have to be associated to confounding effects of the frame measured as bones – larger with adult cows than growing fattening bulls – and the sex – fatter females than males –. The differences could also be associated with a proportional reduction in muscle development with advancing ages. The difference between the 2 sexes was, however, rather small in Belgian Blue breed since the cows were culled at a rather young age for reproduction purposes. The difference would have been much larger with other beef breeds. Assuming that fillet, top loin, steaks and roasts were considered as the most valuable parts of the carcass, they represented around half of the weight of the carcass. The non edible part of the carcass could be considered as a small proportion at 21 and 16% for the females and the males. According to cooking methods, Belgian Blue carcasses can yield 32 and 34% as meat to be broiled (fillet, top loin and first and second class steaks) and 14 and 16% as cuts to be roasted.

Conclusion Carcasses of Belgian Blue culled cows and bulls processed on anatomical cuts basis produced meat pieces available for all the many different culinary preparations but the major characteristic is a proportion of about 50% of high valuable cuts.

Table 1 Weights and proportions of meat pieces from half carcasses of Belgian Blue culled cows and fattening bulls grouped according to culinary purposes

		Weight (kg)				Proportion (%)			
	n cuts	Cows	Bulls	SEM	P>F	Cows	Bulls	SEM	P>F
Fillet	1	4,74	3,84	0,079	***	2,17	2,29	0,024	*
Top loin	3	18,39	12,45	0,256	***	8,42	7,40	0,066	***
Steak (1st class)	5	27,37	23,96	0,362	***	12,56	14,25	0,129	***
Roast - dry heat	5	21,85	20,58	0,319	*	10,01	12,25	0,098	***
Roast - moist heat	3	7,78	6,42	0,123	***	3,56	3,82	0,031	***
Steak (2nd class)	5	19,04	18,10	0,355	NS	8,71	10,76	0,124	***
Lean ground beef	1	18,17	16,59	0,486	NS	8,31	9,80	0,192	***
Stew	2	9,90	9,23	0,218	NS	4,52	5,48	0,074	***
Boiled meat	3	5,34	4,51	0,064	***	2,45	2,69	0,022	***
Minced meat	2	39,37	25,58	0,591	***	18,06	15,24	0,221	***
Fat		14,52	6,09	0,443	***	6,60	3,61	0,165	***
Meatless bones		31,20	20,81	0,536	***	14,25	12,40	0,142	***

NS: non significant; * P<0,05; ** P<0,01; *** P<0,001

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Assessment of cut-off points during Tuberculin skin test for the diagnosis of Bovine Tuberculosis in Cameroonian cattle

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Introduction Bovine tuberculosis (BTb) is a zoonotic disease with severe public health significance but it is neglected in Cameroon. The Single Intradermal Tuberculin (SIT) and Single Intradermal Comparative Cervical Tuberculin (SICCT) tests are the best available for international field diagnosis of BTb in live animals (de la Rua-Domenech *et al.,* 2006a; de la Rua-Domenech *et al.,* 2006b). The SICCT involving the intradermal injection of Bovine tuberculin (BT) and Avian tuberculin (AT) at separate sites in the skin of the neck, gives more specific results than the SIT which uses only BT (Monaghan *et al.,* 1994). There are recommended cut-off points of the increase in skin thickness for a SICCT to be positive (OIE, 2009). However they differ depending on a countries disease status and control programmes (Monaghan *et al.,* 1994; Kazwala *et al.,* 2001; Ameni *et al.,* 2008). The ability of tuberculin skin test to accurately predict the disease status is not constant and depends on environmental factors, prevalence of BTb in tested populations, host factors and nature of the tuberculin used; and a perfect cut-off point in a specific geographic area may not be useful in another (Monaghan *et al.,* 1994; de la Rua-Domenech *et al.,* 2006b; Ameni *et al.,* 2008). Thus, cut-off values for the test under different environmental conditions need to be reassessed. This study assessed cut-off points for SICCT-BT to determine the prevalence of BTb based on the detection of anti-BTb antibodies (anti-BTb Ab) in cattle in the highlands of Cameroon.

Table 1 Anti-BTb Ab detection in cattle and frequency of SICCT-BT/anti-BTb Ab reactors at various cut-off points (Percentage,%; Standard Error,SE)

Variable	No of cattle tested	Anti-BTb Ab reactors (%, ±SE)	Reactors to both SICCT-BT and anti-BTb Ab (%, ±SE)		
			≥ 4	≥ 3	≥ 2
All animals	807	40.90, 1.73	1.36, 0.41	7.9, 0.95	10.36, 1.07
Breed					
Upgraded /Exotic	207	46.24, 3.47	3.19, 1.22	15.94, 2.54	20.73, 2.82
Guadali	492	34.43, 2.14	0.22, 0.21	0.22, 0.21	0.45, 0.30
Namchi	31	24.84, 7.76	0, 0.00	0, 0.00	0, 0.00
Red Bororo	77	74.29, 4.98	4.29, 2.31	38.58, 5.55	50.01, 5.70
Sex, Age and Herd size (No of animals per herd)					
Female	647	39.96, 1.93	1.70, 0.51	7.65, 1.05	9.69, 1.16
Male	160	44.69, 3.93	0, 0.00	8.94, 2.26	13.06, 2.66
Age ≤ 4yrs	481	42.31, 2.25	0.91, 0.43	7.78, 1.22	10.06, 1.37
Age > 4yrs	326	38.81, 2.70	2.02, 0.78	8.10, 1.51	10.80, 1.72
≤ 40 animals	169	31.90, 3.59	1.95, 1.06	9.11, 2.21	9.76, 2.28
> 40 animals	638	43.28, 1.96	1.21, 0.43	7.59, 1.05	10.50, 1.21

Materials and method During June to August 2010, the skin responses to intradermal injections of 0.1ml AT (2500IUml^{-1}) and 0.1ml BT (3000IUml^{-1}) of 807 cattle (20 herds) in the highlands of Cameroon were assessed (Kazwala *et al.,* 2001). The sites, cattle husbandries and selection of herds in the study have been described (Awah-Ndukum *et al.,* 2010). Prior to injecting AT and BT (Lelystad Biologicals, Netherlands), 5ml of blood was collected by jugular venopuncture to detect anti-BTb Ab using Anigen Bovine Tb Ab® (BioNote, Inc. Korea). The consent of animal owners were obtained.

Results The highest ($P<0.05$) prevalence rate was at the SICCT-BT ≥2mm value (12.95%) followed by ≥3mm (8.04%) and ≥4mm (1.36%). Table 1 shows the detection of anti-BTb Ab in cattle and anti-BTb Ab / SICCT-BT reactors at various cut-offs. Overall, anti-BTb Ab was detected in 40.9% of the tested animals with 27.87%, 21.27% and 3.67% of them being SICCT-BT ≥2mm, ≥3mm and ≥4mm reactors, respectively. In all, there were 0.61%, 4.19% and 11.3% SICCT-BT inconclusive but anti-BTb Ab reactors at the ≥2mm, ≥3mm and ≥4mm cut-offs, respectively. More SICCT-BT negative cases ($P<0.05$) at ≥4mm cut-off (45.58%) compared to those at ≥2mm (39.30%) and ≥3mm (40.09%) cut-offs were positive for anti-BTb Ab. Also, 95% anti-BTb Ab reactor herds being mainly ($P<0.05$) SICCT-BT ≥2mm (38.5%) than ≥3mm (33%) and ≥4mm (11%) were noted. Among SIT-BT positive (13.14%) animals 98.59%; 61.23% and 10.38% were SICCT-BT ≥2mm, ≥3mm and ≥4mm, respectively; and also 84.07% SICCT-BT/anti-BTb Ab and 23.87% SIT-AT reactors irrespective of the SICCT-BT cut-off point.

Conclusion The results showed the importance of defining local relevant tuberculin test cut-off values to maximize the detection of BTb and suggest the application of ≥2mm as cut-off for SICCT-BT testing of cattle in Cameroon for significant reduction of BTb. The high prevalence of BTb in cattle in the highlands of Cameroon is confirmed and atypical mycobacterial infection was widespread.

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Effects of stearidonic acid supplementation on methane production evaluated *in vitro*

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Introduction Livestock produce 37% of anthropogenic methane (CH_4), with the majority deriving from ruminants. Strategies to mitigate ruminal methane production are needed both to decrease the negative impact of ruminant production on the environment and to increase feed utilisation. Methanogenic archaea produce methane from carbon dioxide (CO_2) and hydrogen, so increasing the growth of hydrogen-utilising bacteria could decrease methane production. One option to use hydrogen is the feeding of long-chain unsaturated fatty acids that are biohydrogenated in the rumen. Polyunsaturated fatty acids are known to decrease methane production; earlier studies have mainly used C18:3 n-3 or C18:2 n-6 with the inhibitory effect increasing with the number of double bonds (Demeyer and Henderickx, 1967). However, effects were only evaluated up to C18:3 fatty acids, with nothing known about the effects of C18:4 fatty acids, such as stearidonic acid (C18:4 n-3), and other minor polyunsaturated fatty acids that are present in some plants. Consequently, the present study evaluated *in vitro* the effects of increasing levels of stearidonic acid on methane production.

Material and methods The effects of different concentrations (0, 1, 5, 20 and 50 µg/mL) of stearidonic acid were evaluated in batch incubations. Strained rumen fluid collected from three adult dairy cows at a slaughterhouse was mixed with buffer solution (Menke and Steingass, 1988; 1:2, v/v), under O_2-free CO_2. Fifty mL of buffered rumen fluid was incubated with a commercial total mixed ration for dairy cows (400 mg, dry matter, DM, basis) and stearidonic acid for 24 hours at 39 ºC. Incubations were done in triplicate. Volatile fatty acids (VFA) and ammonia ($N\text{-}NH_3$) concentrations, pH, protozoa counts, and total gas and methane production were measured. Results were analyzed using the GLM procedure of SAS (SAS Institute, Inc., Cary, NC). The model included the fixed effect of stearidonic acid concentration, and the residual error. Orthogonal contrast was constructed in order to compare the absence with the addition of stearidonic acid. Linear and quadratic contrast statements were included in the model to test the effect of increasing concentrations of stearidonic acid.

Results Total gas production was not significantly affected by stearidonic acid addition (Table 1). Methane proportion decreased (linearly and quadratically) with stearidonic acid supplementation. However, when expressed as mmol per g of DM incubated, only a tendency for a decrease with stearidonic acid was observed (P = 0.105). Total VFA and pH were not affected by treatments. Ammonia concentration tended to increase linearly with stearidonic acid supplementation (P = 0.088). Compared to the control treatment (0 µg/mL), increasing levels of stearidonic acid led to higher protozoal counts, with highest values when stearidonic acid addition was 5 µg/mL or greater.

Table 1 Effects of increasing amounts of stearidonic acid on fermentation parameters.

	Stearidonic acid (µg/mL)					SEM	Contrast		
	0	1	5	20	50		Control	Linear	Quadratic
Total gas production (mL)	66.90	69.07	71.40	67.13	71.00	4.958	0.631	0.771	0.552
CH_4 (%)	14.65	13.04	12.45	11.67	12.00	0.472	0.001	0.003	0.037
CH_4 (mmol/g DM)	0.99	0.90	0.89	0.79	0.85	0.066	0.105	0.134	0.516
pH	6.45	6.43	6.47	6.45	6.42	0.014	0.597	0.991	0.263
$N\text{-}NH_3$ (mg/mL)	326.92	335.90	342.31	332.05	324.36	4.763	0.235	0.088	0.318
Protozoa (10^3/mL)	85	83	113	117	100	5.5	0.015	0.022	0.185
Total VFA (mmol/L)	69.61	70.54	69.54	69.28	69.22	2.484	0.990	0.921	0.824

Conclusions Long-chain polyunsaturated fatty acids are known to negatively affect methanogenesis either by having a direct effect on rumen methanogenic archaea or by providing an alternative hydrogen sink through biohydrogenation. Stearidonic acid addition decreased methane proportion without negatively affecting fermentation parameters *in vitro*. From these results, stearidonic acid supplementation seems to be a promising strategy to mitigate methane emissions.

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A comparison of two dietary regimes on weights and two morphometric characteristics of Belgian Blue-cross beef cattle over the winter housed period

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Introduction Feeding and fulfilling dietary requirements for optimum growth and weight in beef cattle have always been of great importance to those involved in beef production (Mazzenga *et al,* 2009). Beef producers are always looking at ways to improve the conformation, growth and weight-gain of their cattle and how different feeding regimes have an impact on these characteristics. The aim of this study was to compare weights and two standard morphometric characteristics on cattle fed either forage only or forage plus concentrate diets.

Material and Methods Twenty Belgian Blue-cross heifers born in 2009 between the months of January and May were balanced by weight into two different feeding treatments: the forage plus concentrate treatment referred to as "High" and the forage only treatment, referred to as "Low". The High treatment average weight was (mean ± SE) 318 ± 12.7 kg and the Low treatment average weight was 319 ± 7.5 kg. In the High treatment, cattle were fed 2 kg of concentrate (16 % CP) per head per day as well as *ad lib* grass silage (10.2 MJ/kg ME, 10 % CP). Low treatment cattle were offered barley straw and grass silage (10.2 MJ/kg ME, 10 % CP) *ad lib* with no additional concentrates. Both the treatment groups were housed indoors, bedded on wheat straw with continuous access to an outdoor paved area. All cattle were weighed and measured once every two weeks. Back length was measured in centimetres from between the shoulder blades to the base of the tail using a tape measure. Height at withers was measured in centimetres from the ground to highest point at the shoulders using a height stick. The data was then analysed using a Repeated Measures Analysis of Variance for weight comparisons. Height at withers and back length (recorded at the start and end of the trial) were compared using the student T-test.

Results

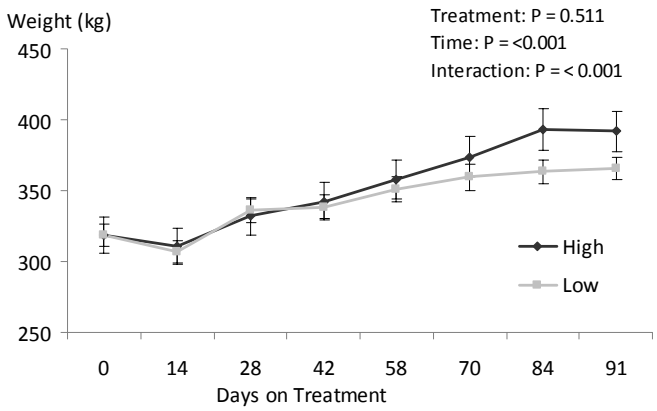

Figure 1 Average weight (kg) over the trial period

The results showed that there was no significant difference between the High and Low treatment with regards to cattle weights over the winter housed period. There were no significant differences in back length between the high and low treatment groups at the start (High: 101.4 cm vs. Low: 104.5 cm; respectively, p = 0.086) or at the end of the experimental period (108.1cm vs. 105.6cm; respectively, p = 0.353). It was seen that the cattle in the High treatment did have the greatest increase in length than those in the Low treatment with a mean growth of 6.67 cm, in comparison to the 1.18 cm mean growth of the Low treatment. Height at withers was also observed to be non significant between the two groups at the start (High: 119.1 cm vs. Low: 118.5 cm; respectively, p = 0.646) nor at the end of the experimental period (123.4cm vs. 121.8cm; respectively, p = 0.385).

Conclusions It can be concluded from the trial that feeding cattle a silage plus concentrate diet does not have a significant effect on weight, height at withers and back length when compared to cattle on a forage only diet. Whilst the higher group were slightly heavier, it is possible that the two dietary regimes investigated were not different enough to impact on the two morphometric characteristics. The research suggests in the case of these cattle it may not be worth feeding concentrates through the winter housed period. Further research is underway to examine the impact of different grazing regimes on these cattle.

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Evaluation of moist co-products for finishing dairy-bred bulls

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Introduction Traffordgold is a moist co-product from the processing of wheat to produce alcohol, starch and wheat gluten for the food and drink industry from Cargill's Manchester distillery. Annual production is currently approximately 280,000 tonnes which is available to feed to livestock. The analysis of Traffordgold is as follows: 470g/kg dry matter, 220g crude protein/kg DM, and 13.4 ME MJ/kg DM. Since feed accounts for 75-85% of the variable costs of beef production, the use of alternative feeds that have a low cost per unit of energy and protein are worthy of investigation. The objective of this experiment was to compare the effect of feeding a Traffordgold/bread/sugar beet feed mix against a high cereal ration on the performance of intensively finished bulls. The rationale for mixing processed bread and sugar beet feed with Traffordgold was to reduce the crude protein to a level more suited to finishing bulls and maintain the high energy content of the mix.

Materials and methods Twenty-four Holstein and ten Angus cross Holstein bulls weighing 330kg were allocated in a randomised block design according to breed and live weight and fed the following diets *ad libitum* through to slaughter; Barley Mix containing (kg/t) 687.5 rolled barley, 100 sugar beet feed, 75 soya-bean meal, 75 rapeseed meal, 50 molasses, 12.5 minerals; Traffordgold Mix containing (kg/t) 580 Traffordgold, 290 processed bread, 130 sugar beet feed plus 125g/head/day of minerals. The Traffordgold mix was ensiled prior to the commencement of the study. The Barley Mix and Traffordgold Mix were analysed to contain 842 and 564g DM, 177 and 173g CP/kg DM, 371 and 298g starch/kg DM respectively. The cattle were housed in straw-bedded pens and were selected for slaughter at EUROP fat class 3. The data was analysed using ANOVA.

Results The bulls fed Traffordgold Mix recorded significantly heavier ($P<0.05$) slaughter weights and lower ($P<0.05$) liver damage scores compared to the barley fed bulls.

Table 1 Animal Performance

	Barley	Traffordgold	s.e.d	Sig
Slaughter weight (kg)	550	572	9.8	*
Days to slaughter	191	184	8.18	NS
DLWG (kg)	1.19	1.28	0.122	NS
Carcase wt (kg)	281	291	6.4	NS
Kill out (g/kg)	511	509	4.5	NS
Carcase daily gain (kg)	0.68	0.72	0.036	NS
Conformation class[1]	2.56	2.64	0.173	NS
Liver score[2]	2.11	1.28	0.359	*

[1] EUROP carcase classification: Conformation: P+=1 and E=7.
[2] Liver assessment: 1= Healthy liver to 5 = Severe abscesses

Table 2 Feed intakes, feed conversion ratio (FCR) and feed cost per kg gain

	Barley	Traffordgold
Total feed intake (kg)	1,704	2,648
Total feed intake (kg DM)	1,435	1,504
FCR (kg DM: kg LWG)	6.40	6.42
Feed cost (p/kg LWG)	95	86

There were no differences in FCR between the treatments. Feed costs were reduced by 9p per kg LWG with Traffordgold Mix based on the costs prevailing at the time of the study.

Conclusions Feeding Traffordgold Mix to bulls resulted in heavier ($P<0.05$) slaughter weights and lower ($P<0.05$) liver damage scores. Liver abscesses are associated with mild acidosis from feeding high starch based diets (Plaizier *et al.,* 2009). It could therefore be assumed that reduced rumen acidosis was responsible for the trend in overall improved performance with the Traffordgold Mix fed bulls. The FCR appears relatively high compared to the target of 5:1 for cereal beef production but it must be taken into consideration that the experiment did not include the period of growth from 110kg to 330kg. During this rearing phase dairy-bred bulls at Harper Adams typically record an FCR of 3.8:1 with a DLWG of 1.55kg. The Traffordgold Mix fed bulls recorded an increased margin over feed of £39 per head with a 10.6% reduction in feed costs per kg gain. From the experiment it can be concluded that feeding moist co-product mixes based on Traffordgold/bread/sugar beet feed to intensively finished beef cattle can help achieve higher slaughter weights and improve financial performance.

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Evaluation of skim and whey based milk replacers on the performance of artificially reared dairy-bred bull calves

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Introduction Many commercial calf rearers believe that when artificially reared calves are fed skim-based rather than whey-based milk replacers that performance is improved and coat bloom scores improve. However, skim-based powders are more expensive than whey-based milk replacers (typically, £150 more per tonne). As a result of this price differential the majority of milk powders on the feed market are whey-based. The objective of this experiment was to compare the effect of feeding either a skim-based or whey-based milk replacer on the performance of artificially reared dairy-bred bull calves to 12 weeks of age.

Materials and Methods Forty Holstein and Continental cross Holstein bull calves were assigned in a randomised block designed experiment with 20 calves per treatment and fed either a skim or whey-based milk replacer. The milk replacers were mixed at 125g per 850ml of water at 40^{o}C and fed twice per day in buckets. The calves were initially fed 4 litres per day and from day 8 milk was fed at 5 litres per day. The skim-based ('Elite', The Calf Company) and whey-based ('Premium Plus', The Calf Company) milk replacers were analysed to contain 942 and 928g DM/kg, 213 and 215g crude protein/kg, 191 and 171g/kg Ether Extract respectively. The skim-based milk replacer contained 300g/kg skim powder. The calves were weaned at 46 days with the milk feed rate being reduced from 5 to 2.5 litres from days 42 to 46. The calves were individually penned on straw and received *ad libitum* concentrates (Start 'n' Wean pellets, Wynnstay Group Plc) plus straw and water. The calves were moved into group pens at weaning. The data was analysed by ANOVA with calves blocked according to weight and breed.

Results There were no significant differences in daily live weight gain (DLWG) and coat bloom score between the treatments.

Table 1 Effect of milk replacer on live weight (kg) and coat bloom score

	Skim	Whey	s.e.d	Sig
Start weight	50.9	51.1	2.07	NS
Weaning weight	72.9	74.8	3.92	NS
12 week weight	115.8	119.8	6.54	NS
Coat bloom score at 12 weeks*	3.15	2.97	0.224	NS

* Coat bloom score scale of 1 = dull, 3 = normal, 5 = shiny

Table 2 Effect of milk replacer on DLWG (g)

	Skim	Whey	s.e.d	Sig
Start - weaning	478	515	67.1	NS
Weaning - 12 weeks	1,129	1,184	83.2	NS
Start - 12 weeks	773	818	64.8	NS

Table 3 Feed intakes (kg/head) and Feed Conversion Ratio (FCR)

	Skim	Whey	s.e.d	Sig
Conc intake (start - weaning)	20.1	21.7	3.48	NS
Conc intake (wean - 12 weeks)	111.0	123.0		
Milk replacer	25.1	25.1		
FCR (kg feed: kg gain)	2.41	2.47		

Concentrate intakes from start to weaning were not significantly different. However the calves on the whey-based milk replacer recorded higher intakes from weaning to 12 weeks and overall consumed an extra 13.6kg more concentrates per calf. The increased concentrate intake with the whey fed calves could be due to improved rumen development. The higher concentrate intake would explain the increased (+3.8kg) live weight gain to 12 weeks old. There were no differences in the health or number of medication treatments between the groups.

Conclusions Calf performance met or exceeded the MLC (1999) target for rearing calves to 12 weeks of 115kg. There were no significant differences in DLWG between calves fed either skim-based or whey-based milk replacer. The calves reared on the whey-based powder recorded higher concentrate feed intakes post weaning and gained an extra 3.8kg in live weight to 12 weeks of age however this was not statistically different. Based on the prices prevailing at the time of the study with skim-based and whey-based milk replacer costing £1,425 and £1,285/t respectively and concentrates costing £192/t, the total feed costs per calf to 12 weeks were £61.97 and £60.03, and the feed costs per kg LWG were 95.5 and 87.4p for the skim and whey treatments respectively.

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Comparison of manual and Video Image Analysis classification systems for the prediction of yield and composition of the loin joint in commercial cattle

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Introduction Video Image Analysis (VIA) is an objective technique for determining the conformation and fat classes of beef carcasses as well as the weight of joints. However, few studies have investigated the accuracy of VIA-applied conformation and fat class in determining the yield and composition of the loin joint of carcasses under commercial conditions. The objective of this study was to compare VIA and manual classification to predict the yield and composition of the loin joint of commercially produced and processed cattle.

Materials and methods In total 135 cattle (< 30 months of age) were selected for inclusion in the trial based on breed and sex in a UK abattoir where a commercial VIA machine (E+V GmbH, Oranienburg, Germany) was operating on-line. On the Monday of each of 6 weeks, eight Charolais-cross, eight Limousin-cross and eight Dairy-cross animals were selected at random for the study. For each breed group, four steers and four heifers were selected per week but bulls were substituted for heifers in the dairy cross group. Age at slaughter, together with VIA-predicted classification data (15 point scales for conformation and fat class), manual classification data (trained classifier operating on the 7 point scale for conformation and fat class used in the UK), weights and VIA primal weight estimations for weight from the right hand half carcass were recorded. At 48 hours post mortem, the intact loin (IL) was removed bone-in and untrimmed from the hind quarter as in Kempster *et al,* (1980), except that quartering was at the $9^{th}/10^{th}$ rib rather than the $10^{th}/11^{th}$. IL was separated by a butcher into the saleable lean meat (maximum 9mm fat at the ¾ point on the 10^{th} rib), excess fat trim and bone components, with each component being weighed. The untrimmed fillet (containing *Psoas major* and *Psoas minor*) was also removed and weighed. Using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC) and including sex as a fixed effect (breed was not significant and significant slaughter day effects were noted but not included as they are irrelevant to the classification process), the accuracy of each model was compared. The following covariates were tested: hot side weight (HSW) [0.5 x hot carcass weight] nested within sex, HSW + Manual EUROP Conformation (MC) + Manual Fatness (MF) (transformed to a numerical scale according to Kempster *et al,* 1986), HSW + VIA Conformation (VIAC) + VIA Fatness (VIAF) and VIA-predicted Striploin weight alone. The loin yield traits to be predicted were intact loin (IL%), loin region saleable meat yield (LRSMY%) and yield of fillet (Fill%) as percentage of HSW. Furthermore, the accuracy of the VIA and manual classification systems was investigated to determine IL joint composition determined as saleable lean meat (MEAT%), excess fat (XSFAT%) and bone (BONE%).

Results In the model used to compare methods of carcass classification, HSW within sex as a covariate accounted for 18% to 24% of the variation in IL%, LRSMY% and Fill% (Table 1). Accuracy increased by including manual or VIA-derived conformation and fatness scores in addition to HSW within sex. These increases accuracy were slightly different for IL% and Fill% depending on the classification system used but similar for LRSMY%. For the loin compostion the difference in explaned variation between manual and VIA prediction was even smaller than for loin yield traits. However VIA classification tended to have lower RSD values for MEAT% and XSFAT%.

Table 1 Effects and classification systems used to predict yield and composition of the loin joint under commercial conditions

Effect/System			HSW+Sex		HSW+Sex+MC+MF		HSW+Sex+VIAC+VIAF	
Loin yield	Mean	SD	R^2	RSD	R^2	RSD	R^2	RSD
IL%	7.16	0.68	18%	0.62	26%	0.59	30%	0.58
LRSMY%	4.34	0.51	24%	0.45	36%	0.42	35%	0.42
Fill%	2.07	0.19	21%	0.17	32%	0.16	27%	0.17
Loin Composition	Mean	SD	R^2	RSD	R^2	RSD	R^2	RSD
MEAT%	60.64	3.88	18%	3.61	28%	3.42	26%	3.39
XSFAT%	9.20	2.79	13%	2.68	25%	2.50	26%	2.44
BONE%	30.15	3.91	37%	3.18	47%	2.92	44%	2.98

Conclusions Inclusion of conformation class and fat class from either manual or VIA classification improved prediction accuracy of yield and composition of loin joints over and above the consideration of HSW and sex. However, further effort is needed to refine and improve accurate and objective methods of prediction under commercial conditions and VIA evaluation should be used to directly predict carcass composition parameters such as loin yield.

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Changes in equol concentrations during technological processing of control and isoflavone-enriched milk

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Introduction Soybean-derived isoflavones have attracted a lot of attention due to their diverse pharmacological properties. However, clinical effectiveness of soy protein is influenced by the ability of human to biotransform daidzein to equol that is more bio-active than its precursor daidzein (Setchell *et al*., 2002). Only 30 – 50 % of adult population is able to convert daidzein into equol (Setchell *et al*., 2002). Oral administration of equol seems to be an alternative for obtaining the health benefits of equol in non-equol producers (Setchell *et al*., 2002). Recent studies suggest (Mustonen *et al*., 2009) that bovine milk can be considered as a potential dietary source of equol. The aim of the study was to determine possible changes in equol concentration during technological processing of milk.

Material and methods Experiment was carried out on four lactating Holstein cows (lactation 2, 22 – 26. week of lactation) with milk production of 18.0 $\pm$ 1.1 kg/d that were divided into two groups, control (C) fed a diet based on extruded rapeseed cake and experimental (S) fed a diet based on extruded full-fat soya. The trial was carried out in a cross-over design and was divided into 2 periods of 14 days (a 10-d preliminary period and a 4-d experimental period). Cows were fed individually twice daily *ad libitum* the diet based on maize silage (508 g/kg), lucerne hay (92 g/kg) and supplemental mixture (400 g/kg) that contained 168 g/kg of extruded full-fat soya in S and 282 g/kg of extruded rapeseed cake in C. Cows were milked twice a day. Feed intake and milk yield was monitored daily. Samples of feed and milk were taken in each experimental period. Further, 20 kg of morning milk was collected in each period per group for technological processing. After collection, milk was cooled to 6 °C, stored overnight at 6-8°C and then pasteurised at 65 °C for 30 min. Cheese was made from 5 kg of pasteurised milk. To curdle the milk, 1.5 ml of saturated solution of calcium chloride and 1 % of cream culture FD was added and milk was then curdled at 32-33°C with liquid rennet (1:15000, MILCOM a.s, Czech Republic). After 80-90 min, 1/3 of the whey was drained and then the curd was supplied with 1/3 of washing water, reheated and drained at 37-38°C for 40-50 min. After draining, curds were poured into the moulds and pressed for 1h under increasing pressure. Cheeses were salted for 3.5 h (20% solution of NaCl) and then they were allowed to ripen for 90 days at 15°C. To make a plain yoghurt pasteurised milk was warmed up to 37°C, inoculated with a 1% of yoghurt cultures KAN IV (*Streptococcus thermophilus, Lactobacillus delbrueckii subsp. bulgaricus*, MILCOM a.s., Czech Republic) and packed into sterile bottles (180 ml volume) with twist-off lid and maintained at 37°C for 16 – 18 h until coagulation. Then the yoghurts were cooled and stored at 6.5° C for 1 month. Samples of feed, milk and dairy products were taken to determine isoflavones concentration using HPLC technique. Data concerning isoflavones intake and equol concentration in milk were analysed using multifactorial ANOVA with treatment, cow, period and day of sampling as factors. Concentrations of equol during processing are expressed as mean and standard deviation.

Results Results presented herein are preliminary. Extruded full-fat soya used in this study contained 378 mg/kg of daidzein, 558 mg/kg of genistein and 130 mg/kg of glycitein resulting in a mean daily isoflavones intake of 1285 mg/d in S that was higher than in C (2.9 mg/d, $P<0.001$). Concentration of equol in milk in S was higher (15.6 µg/L) than in C (3.6 µg/L, $P<0.001$). Changes in equol concentrations during processing are given in Table 1. No effect of pasteurisation on equol concentration was observed. During cheese processing relatively high amounts of equol were transferred into whey. During a 90-day ripening of cheese, concentration of equol decreased by 50 % in C and 38 % in S. After a one-month storage concentration of equol in yoghurts declined in both groups.

Table 1 Concentration of equol (on a dry weight basis) in milk and dairy products during processing

	Units	C		S	
		Mean	s.d.	Mean	s.d.
Raw milk	µg/L	30.4	1.18	189.5	13.03
Full-fat milk prior pasteurisation	µg/L	32.7	0.75	211.8	76.97
Full-fat milk after pasteurisation	µg/L	30.3	1.35	204.7	11.82
Yoghurt after manufacturing	µg/L	46.4	2.01	211.2	14.77
Yoghurt after storage (1 month)	µg/L	44.5	2.70	162.0	2.66
Whey	µg/L	83.1	10.90	213.7	25.20
Cheese after manufacturing	mg/kg	9.7	0.04	42.1	28.40
Cheese after ripening (90 d)	mg/kg	4.8	2.66	26.1	18.92

Conclusion Results of the present study show that, besides milk, dairy products can be also included among possible sources of equol in human nutrition.

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Recurrent exertional rhabdomyolysis – prevalence and possible dietary risk factors in Thoroughbred racehorses

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Introduction Recurrent exertional rhabdomyolysis (RER) is a hereditary myopathy that affects 5-7% of Thoroughbred racehorses and is thought to result from a muscular calcium regulation deficiency. It has welfare implications for the horse due to recurrent episodes of pain, distress and muscle damage and financial implications for the owners and trainers due to treatment costs and days lost to training. Diet has been implicated in triggering episodes of RER however there is limited physiological evidence to support this theory (MacLeay *et al.,* 1999; McKenzie *et al.,* 2003). The aims of this study were to determine prevalence of RER, to quantify the starch, protein, oil and digestible energy (DE) intake of racehorses in training and to ascertain if relationships exist between nutrient/DE intake and episodes of RER.

Materials and methods A questionnaire was designed to obtain the relevant primary data and piloted in the UK. The study population was defined as Thoroughbred racehorses in training in Ireland. Trainers were invited to take part in this study after being selected, using a random number generator, from a list published in Directory of the Turf. The questionnaire was administered face-to-face with trainers that agreed to take part and this also allowed the author to weigh feeds in order to provide accurate information on nutrient and DE intake. 25 trainers took part and provided information on 802 horses in training (approx. 11.3% of the population). In order to determine if there was any relationship between nutrient or DE intake and episodes of RER trainers were divided into 2 groups "Average and below prevalence" and "Above average prevalence". Prevalence of RER in the sample population was calculated (6.7%) and, providing it was in the range set by previous studies (5-7%), used as the figure for average prevalence.

Statistical Analyses An Independent t-test was used to test for differences in starch, protein, oil and DE content fed to racehorses in full work belonging to the 2 groups of trainers. A Pearson's *r* test of correlation was used to assess the relationship between prevalence of RER within a yard and the starch, protein, oil and DE content fed to racehorses in full work.

Results 6.7% (54/802) of the sample population was found to have suffered from RER in the past 12 months with 80% of those being fillies (43). There were no statistical differences between the starch, protein, oil and DE contents of the feeds fed in yards that experienced higher than average prevalence of RER and those yards whose prevalence levels were average or below. There were no significant correlations between protein, oil and DE fed and the prevalence of RER within a yard however there was a significant negative correlation (<0.05) between the quantities of starch fed and the cases of RER (%) that it experienced.

Conclusions Prevalence of RER (6.7%) and a higher susceptibility amongst fillies agreed with previous studies. No differences were found between starch, protein, oil and energy content fed between yards that had average or below prevalence of RER and those that experience above average prevalence of the disease. There were also no correlations between protein, oil and DE fed and prevalence of RER within a yard although a weak negative correlation existed between prevalence and starch fed. These results appear to contradict previous studies and suggest further research is required into the optimum diet required by horses with RER.

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Oleic acid supplementation favours basal prostaglandin E_2 production and antagonizes the effect of oxytocin in uterine endometrial cells isolated from late gestation ewes

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Introduction Oleic acid (OA) is a monounsaturated 18C fatty acid found in many plants. Rapeseed and olive are a major source of OA. Rapeseed meal is widely used as a protein source in ruminant feed and olive oil is consumed by humans. OA is also the most abundant fatty acid present in adipose tissue. Unsaturated 18C fatty acids can inhibit generation of prostaglandins (PG) which play crucial roles in many key processes involving, for example, immune function and reproduction. The aim of the present study was to investigate the effect of OA supplementation on PG production by maternal uterine endometrial (ME) cells isolated from late gestation ewes shortly before the expected onset of parturition.

Material and methods ME cells were isolated from 9 Welsh mountain ewes at 135 days of gestation (term 145 days) using a trypsin-collagenase digestion and cultured to confluence in DMEM/F12 medium containing 10% (v/v) fetal calf serum based on the methods described previously (Cheng *et al.* 2004). ME cells were then cultured in serum free medium containing 0 (CONT), 20 or 100 μM of OA. After 45 h incubation, cells were challenged with control medium (CM) or oxytocin (OT, 250nM). Spent medium was harvested at 24 h after challenge for quantification of PGs by radioimmunoassay. Each treatment was carried out in quadruplicate with cells from at least 3 ewes. Statistical data analysis was carried out using ANOVA with repeated measurement via a linear mixed effect model built in SPSS 18.

Results In the cells cultured in PUFA free medium, OT challenge at 24h increased both PGE_2 and $PGF_{2\alpha}$ production by about 3 fold ($P<0.01$) without a significant change in the PGE_2:$PGF_{2\alpha}$ ratio ($P>0.05$). In the absence of challenge, OA supplementation increased PGE_2 production moderately whereas it decreased $PGF_{2\alpha}$ concentrations significantly ($P<0.05$-0.01), which led to an increase in the ratios of PGE_2 to $PGF_{2\alpha}$ by over two fold ($P<0.01$) (Table 1). In the cells challenged with OT, OA decreased both PGE_2 and $PGF_{2\alpha}$ production by up to 65% ($P<0.01$) (Table 1).

Table 1 Effect of OA supplementation on PG production by uterine endometrial cells isolated from late gestation ewes in the absence (CM) and presence of OA challenge

OA (μM)	Challenge	PGE_2 (ng/ml)	$PGF_{2\alpha}$ (ng/ml)	Ratio (PGE_2:$PGF_{2\alpha}$)
0	CM	13.72 ± 1.70	13.99 ± 0.89	0.99 ± 0.11
20	CM	18.60 ± 2.40	9.72 ± 0.82**	2.07 ± 0.37**
100	CM	20.44 ± 1.92	10.79 ± 1.36*	2.06 + 0.30**
0	OT	38.58 ± 4.81	36.70 ± 5.20	1.25 ± 0.18
20	OT	22.48 ± 6.52**	13.60 ± 0.96**	1.65 ± 0.12
100	OT	21.01 ± 1.92**	15.69 ± 1.55**	1.37 ± 0.10

* $P<0.05$ and ** $P<0.01$ compared with the cells without OA supplementation.

Conclusions OA supplementation favours basal PGE_2 production to increase PGE_2:$PGF_{2\alpha}$ ratios and antagonizes the stimulatory effect of OT on PG production in uterine endometrial cells isolated from late gestation ewes. Our results suggest that consumption of diets high in OA may affect aspects of reproductive function such as luteolysis, pregnancy recognition and the initiation and progression of parturition.

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The effects of replacing traditional inorganic zinc supplements with organically chelated zinc (Bioplex® Zn) supplements on performance in sheep

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Introduction Dietary zinc (Zn) supplements for ruminants have traditionally been inorganic salts, such as zinc oxide (ZnO) or zinc sulphate ($ZnSO_4$). Studies in dairy cows (Cope *et al.*, 2009) and in sheep (Mackenzie *et al.*, 2005) have demonstrated a beneficial effect of replacing inorganic Zn supplements with organic Zn on performance and udder health. The aims of the two studies were to investigate the effects of replacing ZnO with an organic source (Bioplex Zn) on performance of pregnant ewes and their lambs.

Materials and methods Twin-bearing Suffolk cross North Country mule ewes (33 in Experiment 1 and 48 in Experiment 2) were individually penned from 6 weeks pre-partum to 4 weeks post-partum and fed an isonitrogenous, isoenergetic concentrate diet containing one of three treatments: Control (no supplemental Zn), ZnO (an additional 50 mg Zn/kg DM as ZnO) or Bioplex Zn (an additional 50 mg Zn/kg DM as Bioplex Zn). In Experiment 1 the basal diet contained 81 mg Zn/kg DM and in Experiment 2 it contained 46 mg Zn/kg DM. At 4 weeks of age lambs were offered *ad libitum* creep, which was an isonitrogenous, isoenergetic, high fibre concentrate feed. Lambs were weaned at 8 weeks of age. In Experiment 1, the creep contained no supplemental Zn, with a basal level of 140 mg Zn/kg DM. In Experiment 2, creep contained the same level and source of supplemental Zn as fed to the dam, with a basal level of 52 mg Zn/kg DM. In Experiment 2 one lamb from each ewe was individually penned at weaning until 15 weeks of age and given *ad libitum* creep containing the same level and source of supplementary Zn as the dam. Ewes and lambs were weighed on a weekly basis in both experiments. In Experiment 2, ewe hoof hardness was measured at lambing according to the method of Cope *et al.* (2009). Results were analysed using Genstat ANOVA with protected least significant differences.

Results No significant effects of supplementing the basal diet with 50 mg Zn/kg DM was observed on ewe liveweight change, lamb birth weight, weaning weight or growth rate, regardless of Zn source (Table 1). In Experiment 2, hoof hardness at lambing was significantly greater in ewes receiving the Bioplex Zn diet compared to those fed either the Control or ZnO diets.

Table 1 Effects on ewe and lamb performance of supplemental Zn as either ZnO or Bioplex Zn.

	Control	ZnO	Bioplex Zn	s.e.d.	P
Experiment 1					
Intial ewe liveweight (kg)	75.3	75.4	75.5	1.00	NS
Ewe liveweight change *pre partum* (kg/d)	9.0	8.5	8.0	1.23	NS
Ewe liveweight change *post partum* (kg/d)	-12.3	-9.3	-13.1	2.3	NS
Lamb birth weight (kg)	4.7	4.3	4.8	0.27	NS
Lamb weaning weight (kg)	20.0	20.0	21.0	0.83	NS
Lamb growth rate[1] (kg/d)	0.28	0.28	0.29	0.013	NS
Experiment 2					
Initial ewe liveweight (kg)	79.4	77.4	79.2	1.44	NS
Ewe liveweight change *pre partum* (kg/d)	10.9	8.9	10.6	1.08	NS
Ewe liveweight change *post partum* (kg/d)	-6.4	-10.0	-7.2	1.73	NS
Ewe hoof hardness (S)	56.8[a]	55.6[a]	60.6[b]	1.77	0.025
Lamb birth weight (kg)	4.8	4.6	4.8	0.20	NS
Lamb weaning weight (kg)	19.0	20.3	19.4	1.40	NS
Lamb liveweight, week 15 (kg)	36.3	38.2	35.2	2.15	NS
Lamb growth rate[1] (kg/d)	0.22	0.24	0.22	0.011	NS
Lamb growth rate[2] (kg/d)	0.33	0.37	0.33	0.028	NS

[ab]means with different superscripts within a row differ significantly; S = Shore units; [1]pre-weaning; [2]post-weaning

Conclusions The results suggest that replacing inorganic Zn salts with Bioplex Zn at a supplementary level of 50 mg Zn/kg DM has no effect on ewe and lamb performance. However, organic Zn supplements can improve ewe hoof hardness at lambing. In a study by Mackenzie *et al.* (2005), lambs born to ewes fed a diet containing 260 mg Zn/kg DM as Bioplex Zn had a significantly greater growth rate compared with lambs born to ewes fed a diet containing 288 mg Zn/kg DM as ZnO (0.264 kg/d vs. 0.232 kg/d; $P<0.05$). Thus, it is possible that supplementing ruminant diets with organic forms of Zn at high concentrations has a beneficial effect on performance.

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Footrot and other foot conditions in hill and lowland sheep: effects of flock, ewe breed, age and litter size

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Introduction Abnormal foot conditions leading to lameness can represent a major cost in sheep production, both in terms of lost production and the significant labour input required to address the problem. Although most studies have focused on footrot there are a number of other foot conditions affecting sheep, as described by Conington *et al.* (2010) and Winter (2008). There is a paucity of information on the factors which affect the incidence and severity of these conditions. The objective of this study was: (1) to determine the incidence of four of the main foot conditions in ewes during lactation, namely, interdigital dermatitis (scald), footrot, shelly hoof and overgrown hoof, and (2) their association with flock, ewe age, breed, litter size and lambing date.

Materials and methods Ewes in five lowland flocks (n= 779) and four hill flocks (n=394) yielded data for the study. Within the lowland flocks five main ewe breed types were represented (Belclare-X, Suffolk-X, Texel-X, Charollais-X and Cheviot-X); all the ewes in the hill flocks were Scottish Blackface. Ewes were individually identified and had lambed in spring 2010; lambing date and litter size were recorded at lambing; age at lambing was categorised as 2, 3 or ≥ 4 years. At approximately 7 weeks post-lambing all ewes were examined, and each foot was individually scored for the presence/absence of interdigital dermitis, footrot, shelly hoof and overgrown hoof. The incidence values were summed for each condition to give a score for each ewe; these scores were subjected to a square root transformation, prior to statistical analysis, to normalise the distributions. Each ewe was also categorised as having each condition (score > 0) or not to provide an overall incidence for each condition. Score data were analysed using least squares procedures (Proc GLM; SAS 2009) to fit a model with fixed effects for flock, ewe breed and ewe age with litter size and lambing date as covariates. Phenotypic correlations were calculated among the conditions examined (Proc CORR; SAS 2009).

Results The incidence of each of the four foot conditions is summarised, by flock, in Table 1. Flock differences were significant (P<0.001) for all foot scores in both Hill and Lowland data sets, and these differences reflected the differences in incidence (Table 1).

Table1 Incidence (%) in lowland and hill flocks (at least 1 foot infected)

Condition	Lowland flocks					Hill Flocks			
	1	2	3	4	5	1	2	3	4
Footrot	38.7	0	13.4	8.5	0	4.4	1.7	7.8	23.0
Interdigital dermatitis	35.5	0	41.3	29.8	16.9	16.2	0	24.0	24.1
Shelly hoof	35.5	14.5	15.5	57.5	18.6	42.7	43.3	33.5	0
Overgrown hoof	96.8	92.3	41.6	31.9	44.8	61.8	40.0	27.9	20.7

Hill flocks Interdigital dermatitis score increased with ewe age (P<0.001) but was not significantly effected by either litter size or lambing date. The score for shelly hoof was significantly affected by ewe age (P<0.01; higher in older ewes) and there was a negative relationship with litter size. No other significant effects were observed. Interdigital dermatitis score was correlated (P<0.05) with both shelly hoof score (-0.14) and overgrown hoof score (-0.10).
Lowland flocks Interdigital dermatitis score increased with ewe age (P<0.05) and was positively related to lambing date (P<0.05) (i.e., increasing with later lambing); ewe breed type also significantly (P<0.05) affected this score, due essentially to a higher value for Charollais-X ewes. There was no evidence for any effect of ewe age or litter size on interdigital dermatitis score. Ewe age was the only factor that significantly affected the score for footrot (P<0.05). Shelly hoof score was positively associated with both ewe age and litter size (P<0.001) but there was no evidence for any effect of ewe breed type or lambing date. The only evidence for effects of animal factors on the overgrown hoof score was a positive relationship with litter size (P<0.01) and a tendency (P=0.07) for an increase with ewe age. There were a number of significant correlations among the conditions examined; shelly hoof score was correlated (P<0.05) with interdigital dermatitis (-0.13), footrot (-0.07) and overgrown hoof scores (-0.09), there were no other significant correlations.

Conclusion The large variation between flocks in the incidence of the various foot conditions suggests that flock management or other farm specific factors are important; there is clearly a need for effective control strategies. The contrast between hill and lowland flocks for the relationship between litter size and shelly hoof score indicates that explanations based on a simple nutritional deficiency may not be adequate.

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Evaluation of fresh wet brewers grains as a replacement in a conventional fattening ration: intake, digestibility and nitrogen balance in goats

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Introduction Agricultural by-products are cheap sources of nutrients that can be used to reduce costs of conventional fattening rations. One agricultural by-product that is usually considered as waste and available throughout the year is brewers grains. The study was carried out to investigate the effect of partial replacement of a commercial fattening ration with wet brewers grains on performance of Small East African goats.

Materials and methods Twelve castrated goats, 20±1.8 kg, were allocated to three dietary treatments in a completely randomized design with each treatment having four animals. The dietary treatments were 100% fattening ration/Enerfeed (Diet A), 70 % Enerfeed + 30% brewers grains (Diet B) and 50% Enerfeed + 50% brewers grains (Diet C). Animals were fed *ad-libitum*, 5 to 10 % refusals were allowed, once a day at 0600 hours for 69 days. The goats were adapted to their respective diets for fourteen days. Digestibility and nitrogen (N) balance of dietary treatments were measured for 7 days after adaptation period. Dry matter intake (DMI) was measured for 69 days and weights were measured weekly. Dry matter, crude protein, ether extract, crude fibre and ash were determined according to AOAC (1995). Data were analysed using Genstat 4 software. Difference in dietary treatments was determined by analysis of variance. Comparison of voluntary feed intake (VFI), DMI and digestibility were done with ANCOVA and initial live-weight was used as a covariate. A least significant difference test was used to compare the means.

Results The dietary treatments differed in all nutrients analysed (P<0.001). As expected partial replacement of fattening ration with brewers grains reduced DM content of both Diet B and C (Table 1). Increase in crude protein, crude fibre and ether extract were observed with increase in partial replacement of Enerfeed with brewers grains (Table 1).

Table 1 Chemical composition of diets fed to goats on a % dry matter basis

	Treatments		
Nutrients	Diet A	Diet B	Diet C
As fed DM %	92.6 ^{a} ± 0.3	71.5 ^{b} ± 0.3	57.7 ^{c} ± 0.3
Crude protein	12.7 ^{a} ± 0.3	13.8 ^{b} ± 0.3	15.7 ^{c} ± 0.3
Crude fibre	8.2 ^{a} ± 0.2	9.0 ^{b} ± 0.2	9.9 ^{c} ± 0.2
Ether extract	4.2 ^{a} ± 0.6	4.7 ^{b} ± 0.6	5.4 ^{c} ± 0.6
Ash	6.8 ^{a} ± 0.1	6.2 ^{b} ± 0.1	5.8 ^{c} ± 0.1

Within a row, means not sharing a common superscript are significantly different (P < 0.05)

Digestibilities of nutrients in dietary treatments were similar (P>0.05). The average apparent and N digestibility of dietary treatments was high, 70% and 72% respectively. The DMI was similar for all diets (P>0.05) with average of 530 g/day. However, VFI of Diet B and C was higher compared to Diet A, 912, 807 and 500 g/d respectively (P<0.01). This was probably due to high moisture content from brewers grain inclusion. Even though N digestibility was high, low N retention was observed for all diets. Final weight of goats fed Diet B and C was higher than Diet A, P<0.01 (Figure 1).

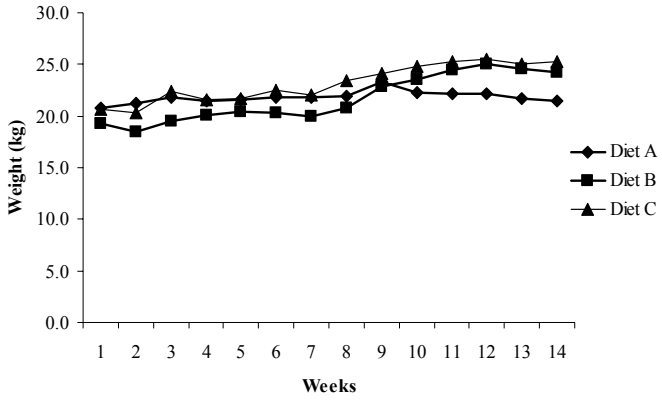

Figure 1 Mean weekly live weight (kg) of goats

Conclusion The partial replacement of Enerfeed with brewers grains improved nutrient content of fattening ration at both 30 and 50% level. Weight gains were improved by replacement of Enerfeed with brewers grains due to increased VFI. Dry concentrates may be dusty and that may affect the VFI, especially in goats. Swaziland produces thirteen tonnes of brewers grains per day and currently the product is considered as waste suggesting that it could be a valuable and economic component of feed rations.

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Preliminary study of Balangu, an intermediate moisture meat made from beef compared, with mutton and chevon, for food security

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Introduction Meat and meat products are highly perishable, due to their high nutrient density, high moisture content and favorable ultimate pH value (e.g. 5.4 -5.6 for beef) For meat to be readily accessible, available, affordable and highly utilized to meet food demand in Nigeria, meat requires preservation. The need for effective cheap and simple preservative techniques cannot be over emphasized. One of such simple preservative techniques is employed to process meat and other foods to semi-dried food / meat with lowest water activity of intermediate moisture level of 15 - 40 % by drying and or infusing with seasoning like salt and glycerol Okodugha and Obanu (1981). For meat consumption in Nigeria to meet FAO requirement meat is preserved into meat product e.g Kilishi, Kundi, Suya, Balangu etc. Balangu is a intermediate moistur meat (IMM), that is highly nutritious and, could help to combat malnutrition and is widely acceptable by all tribes in Nigeria there is a dearth of information on the production as well as the nutritional and eating qualities of this product. It is therefore, the aim of this study to evaluate the chemical and eating qualities of Balangu.

Materials and methods A 4kg sample of semitendinosus muscles from White Fulani and West African Dwarf Sheep and Goat– male animals of ages 1-2years, were purchased from the Animal Science Department, and processed in the Meat Science Laboratory. Muscles were trimmed of all visible particles, bone and connective tissues, held at 4 ^{0}C for 24 hours and cut into flat-thick shapes– of different sizes and weights, air dried on the laboratory table after washing. Samples were later oven dried at 70 ^{0}C for 15 minutes and later infused with mixture of groundnut paste which include salt, groundnut, vegetable oil and monosodium glutamate, and continued to be oven dried for another 40 minutes. Freshly prepared Balangu from beef, mutton and chevon were evaluated for its chemical and eating qualities in a completely randomized design.
Proximate analysis of moisture, ash, ether extract and protein was measured according to A.O.A.C (2000).
Eating qualities was evaluated by the Panelist according to the method used by Fakolade (2008).
All data was subjected to analysis of variance (ANOVA), and significant means were separated using the Duncan's Multiple Range (DMR) test. The SAS computer package was used for all statistical analysis (SAS, 1999).

Results Beef Balangu had the highest protein content but the least fat, with no difference between species for moisture content (Table 1).For the eating qualities, beef was rated highest by the panel with 7.10 for beef, 6.00 and 6.40 for mutton and chevon respectively.

Table 1 Chemical Composition of Balangu made from beef, mutton and Chevon g/100gDm.

Parameter	Treatments			
	Beef	Mutton	Chevon	SEM
Moisture	14.16	15.73	16.53	0.22
Ash	2.05^a	1.32^b	1.22^b	0.36
Ether extract	7.22^c	10.16^b	13.17^c	0.59
Protein	76.57^a	72.79^b	69.09^c	0.28
Eating quality	7.10	6.00	6.40	0.41

^{ab} means in the same row with different superscript are significantly ($P<0.05$) different.

Conclusions This results shows that Balangu, an IMM with high protein percentage, from beef has a high nutritive value with high protein and low fat, being more acceptable to sensory panel than that from sheep or chevron. This preservation method reduces meat spoilage whilst retraining good nutritive value and eating acceptability so could be produced to reduced malnutrition in children and adult.

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The effects of environmental and physiological factors on the incidence of lameness in dairy sheep

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Introduction Lameness is a challenging issue for the sheep industry both in terms of productivity and welfare (Winter 2004). Research so far has focused on lameness of meat producing breeds, whereas in dairy sheep there is limited information. The issue is important particularly in Mediterranean countries where the majority of dairy sheep are reared (Gelasakis *et al.,* 2010). Hence, the objective of the present study was to assess the effects of environmental (flock size, stocking density, grazing status) and physiological (age, parity, lambing season) factors on the incidence of lameness in intensively reared flocks of dairy sheep in Greece.

Materials and methods A k-means cluster analysis was applied using 66 flocks of the Chios Sheep Breeders' Cooperative "Macedonia"; flock size, stocking density and grazing status were used as grouping factors. Three dominant clusters were recognized; three flocks from each cluster comprising a total of 1618 ewes were selected. These ewes were examined for lameness every 14 days over one lactation period. Lame ewes were subjected to a detailed clinical examination to determine the cause of lameness. Individual ewe data concerning lambing season, age at lambing and number and duration of lactation were obtained from the cooperative's data base. The following general linear model was developed to assess the impact of these factors on the incidence of lameness:

$$Y_{ikns} = u + SD_s + G_n + LS_k + P_i \times a_1 \cdot age + a_2 \cdot ewes + a_3 \cdot milk + e$$

where: Y_{ikns} = Incidence of lameness, u = overall mean, SD_s = fixed effect of stocking density (s=1,2), G_n = fixed effect of grazing status (n-1,2), LS_k = fixed effect of lambing season (k=1, 2), P_i = fixed effect of parity number (i=1-5), a_1 = linear regression on age at lambing, a_2 = linear regression on flock size, a_3 = linear regression on lactation milk yield corrected for duration, e = random residual.

Results The overall incidence of lameness was 6.8%, varying from 0.4-22.0% among the 66 flocks; the commonest cause of lameness was footrot (66.4%), followed by white line abscesses (16.4%) and white line disease (11.8%). Results of the impact of various factors on incidence of lameness in the 9 flocks selected after the cluster analysis are shown in Table 1. A positive association between incidence of lameness and stocking density was found (P≤0.001). Larger flocks had lower incidence of lameness (P≤0.05), which was, also, lower in grazing than non-grazing ewes (P≤0.05) and was significantly associated with parity (P≤0.001); second parity ewes were more susceptible.

Table 1 The effects of stocking density, grazing, flock size, lambing season, parity and milk production adjusted for the duration of lactation, on the incidence of lameness

	Degrees of freedom	F-value	P-value
Stocking density (1=<2m^2, 2=≥2m^2)	1	19.801	0.000
Grazing status (1=yes, 2=no)	1	4.445	0.035
Lambing season (1=Oct.-Dec., 2=Jan.-Mar.)	1	1.301	0.254
Parity (n) x Age at lambing (months)	5	8.581	0.000
Flock size (number of ewes)	1	6.130	0.013
Milk production (lt) adjusted for duration of lactation	1	0.592	0.442

*P≤0.05, ***P≤0.001

Conclusion The strong relationship between environmental factors and lameness means that sheep producers need to change their approach to confront lameness by adjusting the factors associated with it, especially by lowering stocking density and providing grazing opportunities. Both practices are important in the case of intensively reared flocks.

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The peroxide value and thiobarbituric acids profiles of palm oil decanter meal kept over extended time

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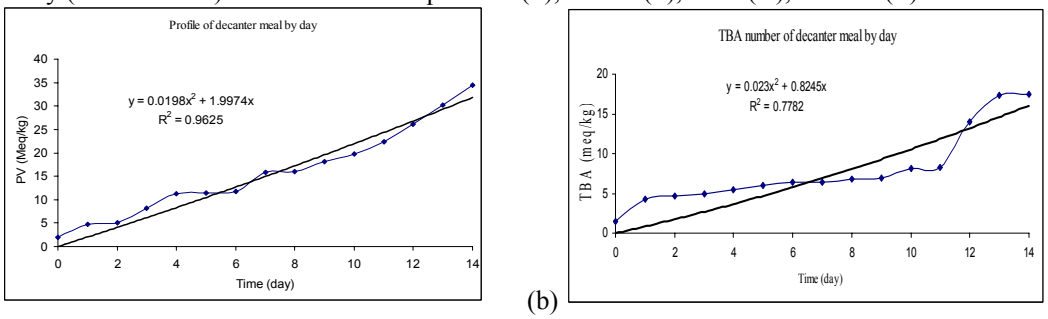
Introduction Decanter meal (DM) is a pasty-type, by-product derived from mechanical extraction of crude palm oil from oil palm (Elaies guinensis) fruit. The non-fluid nature of DM is the result of decanting, centrifuging and thermal application. It is being used in feeds for ruminant and aquaculture, and contains 81.65, 12.63, 7.12, 25.79, 0.03, and 0.003 %, respectively, dry matter, crude protein, ether extract, crude fibre, calcium, and phosphorous and 154.52 kcal/kg energy (Utomo *et al,* 2004). If allowed to stand, decanter meal will turn rancid and mouldy, in a few days. Information on the rancidity profile of DM is not known. A study was conducted to monitor the peroxide value (PV) and thiobarbituric acids (TBA) contents as indices of rancidity, of DM from the point of its production to up to 14 days. The information obtain is necessary to device measures to improve its keeping quality.

Materials and methods A 14 kg of fresh DM was collected from a local crude palm oil extraction plant. Fresh samples, in open plastic containers, were placed in an open house at room temperature. A kg of representative sample was collected every 24 hours after time of collection and sampling was repeated everyday for 14 consecutive days. Each of the samples were put in air-tight plastic bags and stored at -20 ^{0}C prior to analysis. The samples were analysed for PV (Vanhanen and Savage, 2006) and thiobarbituric acids (TBA) number (Tadlargis, *et al.,* 1960) and fatty acids (FA). PV and TBA are associated with the oxidative and hydrolytic rancidity, respectively. FA were determined by extraction of FA methyl esters followed by separation using gas chromatography. Analysis of correlation coefficient between times of sampling and rancidity, between rancidity and FA composition of fresh DM were done using Microsoft SAS 9 (2008)

Results The relationship between the time of sampling and PV and TBA of DM followed a polynomial regression (Figure 1a and 1b) with correlation coefficient (R^2) values of 0.9625 and 0.7782 for PV and TBA respectively, although both PV and TBA values seems to plateau at day 6, began to rise again on day 10 and plateau again on day 13. The R^2 between rancidity (PV and TBA) and FA which are palmitic (P), stearic (S), oleic (O), linoleic (L) is shown in Table 1.



(a) (b)

Figure 1 PV (a) and TBA (b) of PODC during 14 days observation.

Table 1 The R^2 value between rancidity indices and selected FA

	P	S	O	L	Ln
PV	0.61	0.16	-0.82	-0.30	-0.84
TBA	0.40	0.34	-0.91	-0.02	-0.62

Table 2 Selected fatty acids composition (g/kg) of DM

	P	S	O	L	Ln
Fresh	400.9	52.8	408.4	108.5	10.3
14th day	408.9	57.7	359.2	107.6	9.5

The R^2 values between rancidity and P and S is positive but it is negative for O L and Ln. The relationship between rancidity and O is very high with R^2 of -0.82 and -0.91 for PV and TBA respectively. This indicates a high relationship with O, FA composition within DM (Table 2). The R^2 between rancidity and L is less than that between rancidity and O as the composition of L is low within DM. The R^2 between rancidity of DM and L is also very negatively low with R^2 -0.30 and -0.02 for PV and TBA respectively.

Conclusion Both PV and TBA value initially increase at day 3 as it indicates rancid. The rancidity might be caused by O as it is the main concentrated unsaturated FA in DM

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