TRANSLATION

The Swedish University of Agricultural Sciences

Institute of Biosystems and
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Alnarp

Test of different types of potato pulp in a feeding experiment with heifers

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Background

At starch extraction from potatoes, a rest product, the so-called potato pulp, is obtained. Traditionally this pulp is used for animal feed, mainly in beef production, in areas close to the starch factories.

Potato pulp is regarded as a cheap feed that is readily consumed by the animals. The nutritional value of the dry matter is high, but the water content is high, ca 87%. Therefore the product has a low concentration degree, and is ranked among the traditional so called juicy feeds. Of such products it is normally recommended that the maximum amount given should not exceed 2.5 kg dry matter or 20 kg wet feed per animal and day in order to reach an efficient feed utilization.

In their efforts to create improved starch products Arnylogene HB has developed a genetically modified potato variety. In common potatoes the starch consists of ca 25% amylose, a straight structural chain, and ca 75% branched amylopectin. Amylopectin is likely to be digested more rapidly in the digestive duct than is arnylose. It also has a larger water absorption capacity. In the genetically modified potato variety the starch is almost exclusively arnylopectin. The extraction of starch is not complete, leaving about 15% starch (and sugar) in the pulp. The probability that the change of starch type in the modified pulp should influence the feed utilization due to a possible difference in digestive speed is, however, small, at least when traditional feed compositions a used, i.e. a limitation to 2,5 kg dry matter.

In order to study possible effects of the genetically modified pulp, the author was commissioned by Amylogene HB to carry out a comparative feeding trial during the winter 1999-2000, involving common and modified pulp and recruiting heifers of race SLB (Swedish Friesian Breed). Permission for the feeding trial has been granted by the Swedish Competent Authority concerning the potato clone EH92-527-1 (Dnr 22-1087/99).

Project plan

Experimental model

The trial was planned as a so-called roman square or changeover model with two trial periods and two treatments (Table 1). The two treatments were one control feed composition with common potato pulp and one trial composition that included the genetically modified pulp. Additionally the animals were observed during a 4-week period following the trial period. After the first trial period the pulp type was changed among the animal groups, allowing all animals to consume both feed types.

Table 1. Experimental model

	Period I (8 weeks)	Period II (8 weeks)	Post-trial Period (4 weeks)
Group I (16 animals)	GMO-pulp	Common pulp	No pulp
Group II (16 animals)	Common pulp	GMO-pulp	No pulp

Animal material

32 SLB heifers were selected for the trial, and were randomly divided into two groups, I and II. The animals were 13 to 19 months of age at the start of the trial, and none of them were pregnant. About half of them were inseminated during the experimental period. With respect to nutritional needs the animals were divided into four weight classes. The numbers of animals in each weight class are shown in Table 2**.**

Table 2. Allocation of animals in weight classes at experimental start.

	Weight class			
	A (376-425 kg)	B (426-475 kg)	C (476-525 kg)	D (526-575 kg)
Group I	4	6	4	2
Group II	5	4	5	2

Body weight

The heifers were weighed at the experimental start, at the end of it, and a couple of times during the two trial periods 1 and 2.

Trial feed

When potato pulp is used as feed on farms situated close to the starch factories, it is normally continuously delivered during the winter and is consumed in a relatively fresh condition. The distance between the research station at AInarp and the factories is, however, to long to allow for a continuous delivery. Additionally the starch extraction from genetically modified potatoes took place only during a short period during the winter. Therefore it was decided that both pulp types should be stored at AInarp. The total need was calculated to ca 40 tons of each pulp type, including storage losses.

Both pulp types were delivered to Alnarp at the same day. They were stored on concrete floors, covered with plastic, and were sidewise supported by a concrete wall and bales of straw. The aim of the plastic cover was to protect from rain. The height was ca 1 m at the most.

Other feed components used were grass silage and grain, and to a minor extent also a protein supplement. The animals also had access to straw. Samples of the feed components were taken every day. Wet samples were frozen. The day-samples were combined into 14-day samples (silage) or 4-week samples (concentrate mixtures), which were analysed by AgroLab in Kristianstad. The chemical composition and calculated nutritional content of the feed components are shown in Tables 3 and 4. Crude forage feed is shown in Table 3, and grain mixture HKV and protein supplement PROT is shown in table 4**.**

Feed composition

The heifers were individually fed twice every day'. The feeding was planned for a daily weight gain of 800 g for the smaller individuals and 700 g for the larger ones. The feeding within the abovementioned weight classes is shown in Table 5. The supply of grass silage and Mixture HKV was automatic, utilizing a computerized device, while the potato pulp was manually weighed. The potato pulp constituted slightly more than 30% of the total feed calculated on a dry matter basis. Feed residuals were weighed every morning, except for straw residuals, since straw was not weighed initially.

Table 3. Chemical analyses and nutritional values in feed.

	Grass silage	Ordinary pulp	GMO-pulp
Dry matter, %	30.2	14.1	13.7
In % of dry matter			
Crude protein	17.4	13.2	15.1
Ether extract	2.5	0.16	0.32
Crude protein		21.9	23.1
Ash	8.2	8.4	8.9
NDF-fiber	42.4	31.3	32.7
Per kg of dry matter			
Metabolizable energy, MJ	11.46	10.90	10.60
Digestible crude protein, g	132	70	80
Amino acids absorbed from Intestine, g	73	100	102
Protein Balance Value in rumen, g	47	-29	-12

Table 4. Concentrate mixtures, ingredients and calculated nutritive values

Ingrediens, %	Mixture HKV	Mixture PROT
Oats	25	
Barley	45	
Wheat	30	
Peas		22.5
Dried distiller's grain		12.5
Rapeseed meal		15.0
Rapeseed cake		35.0
Dried beet pulp		15.0
Per kg of dry matter		
Metabolizable energy, MJ ME	11.69	12.22
Digestible crude protein, g	73	204
Amino acids Absorbed from Intestine, g	75	128
Protein Balance Value in rumen, g	-27	50

Table 5. Used rations at different weight classes. Amount per animal per day.

	A 376-425 kg	B 426-475 kg	C 476-525 kg	D 526-575 kg
Needs according to standards				
Metabolizable energy, Mi ME	73	78	-82	87
An-dno acids Absorbed from Intestine, g	475	507	533	566
Digestible crude protein, g	555	577	590	600
Ca, g	32	34	37	39
P, g	27	29	31	33
Dry matter, max kg	7.0	7.5	8.1	8.6
Daily feeding				
Grass silage, kg of dry matter	2.5	2.7	3.0	3.5
Pulp, kg of dry matter	2.0	2.2	2.4	2.6
or Pulp, kg of feed	15	17	19	21
Mixture HKV, kg	1.1	1.5	1.2	1.0
Mixture PROT, kg	0.2	-	-	-
Minerals, g	100	100	100	100
Straw ad libitum, kg	1	1	1.2	1.5
Pulp, % of total dry matter	31	31	32	32

Results and discussion

Hygienic quality of the Pulp

Normally potato pulp is used fresh, or it is stored on farm. Common practice at storage involves unloading directly on the ground or on a concrete floor without covering it. The surface layer is therefore destroyed by mould, but usually the surface dries out and the infested layer is quite thin. In the AInarp experiment efforts were made to protect the pulp and to favour the silage process by means of a plastic cover. Apparently this measure did not have the intended effect. The surface did not dry out, and the mould growth was favoured. Therefore a rather thick layer had to be removed every day on both pulp types in order to avoid that the animals were supplied with rotten feed. A consequence of this was that the experimental periods had to be reduced by about one week each.

A difference between the pulp types was that more juice ran off the GMO-pulp. The chemical analysis (Table 3) indicates a somewhat higher dry matter content in the GMO-pulp. At the same time the protein and fibre contents were higher. Texture and smell were similar.

Feed consumption

Prior to the trial none of the heifers had been fed with potato pulp. Therefore the pulp proportion of the feed was increased gradually during the first days. Most of the animals consumed the feed with delight, but two of them left large amounts during the whole experiment - independent of pulp type. Consequently no difference with respect to tastiness between GMO-pulp and ordinary pulp could be registered. When the feeding with pulp was interrupted it was noted that the animals missed the feed, even if they got more of grass silage.

The average feed consumption per animal and day during the two experimental periods is shown in Table 6. The somewhat smaller feed consumption in Group I during both experimental periods mainly refer to the two heifers with a lower consumption. Straw is not included in Table 6. The consumption is estimated to 1.5 - 2 kg per day, giving an energy supply of about 10 MJ. In Period 1 this gives a nutritive supply that agrees very well with the plan according to Table 3. In Period 2 the nutritive supply decreased in both groups as a consequence of the dry matter content of the grass silage being lower than the record of the preliminary analysis of the feed. This hit both Groups identically.

Table 6. Average feed consumption per animal per day. Straw not included.

	Group I, n=16		Group II,	n= 16
	Period 1	Period 2	Period 1	Period 2
Feed amounts, kg				
Grass silage	10.3	7.1	10.3	7.4
Pulp, ordinary	-	15.6	16.8	-
Pulp, GMO	15.5	-	-	17.0
Concentrate HKV	1.3	1.2	1.3	1.2
Concentrate PROT	0.1	0.1	0.1	0.1
Nutrient consumption per day				
Dry matter, kg	8.70	8.24	8.86	8.44
Metabolizible energy, MJ	71.92	65.53	74.55	66.95
Digestible Crude Protein, g	587	478	583	510
Amino acids Absorbed, g	363	390	551	521
Protein Balance Value, g	72	-10	30	33
Starch, g	704	715	681	695
NDF-fibre, g	2315	1983	2326	2110
Crude protein, % in dry matter	11.1	9.8	10.6	10.5

Gain of weight

The increase of weight during both experimental periods and the subsequent 4-weeks period is shown in Diagram 1 (note: the diagram cannot be included in the e-mail transmitted version of the translation, but will be attached to the version sent by mail). The weight development in the two groups is completely parallel, and the small difference in average weight recorded at the initiation of the experiment remains during the whole experiment. The average daily weight increase per animal is shown in Table 7. In an analysis of variance (GLM-Anova) of the weight figures, no significant differences between treatments/pulp types are revealed (P=0.61). Also between the two animal groups there are no significant differences (P=0.74). The difference in weight increase between periods, however, is significant (P=0.002**), which is indicated also in Diagram 1.

Table 7. Average daily gain per animal in different periods. Mean, standard deviation and significance value.

	GroupI	**Group II**	**Significance** (P-value)
Period 1	707±162	743±175	
Period 2	593±191	585±142	
Period 1+2	650±184	664±176	P=0.74 NS
Ordinary pulp	591±191	741±176	
GMO-pulp	707±162	585±142	
	Ordinary pulp	**GMO-pulp**	
Group I+II	668±l96	646±162	P=0.61 NS
	Period 1	**Period 2**	
Group I+II	725±167	589±165	P=0.002**

Animal health

The health status of the animals was regularly observed and abnormalities were noted. No influences, which could be caused by the pulp feeding, were identified. The two heifers leaving large amounts of feed residuals were healthy. Some cases of loose manure were noted, but that could not be associated with the pulp, since the same symptom simultaneously occurred in other animals in the same stable, which were not fed with pulp.

Conclusion

The comparative study between ordinary potato pulp and the genetically modified type from EH92527-1 shows that no statistically significant differences regarding gain of weight in heifers could be established when the feed contained just over 30% potato pulp calculated on the dry matter content of the feed, or 2.0 - 2.6 kg pulp dry matter depending on the weight of the individual animals. Both types of pulp were readily consumed by the 30 out of 32 animals. The remaining two animals consumed considerably less of both types than their mates. No effects on health or intestinal flinctions were noted which could be tied with the pulp feeding.

Summary

In the actual study, commissioned by the Amylogene HB and carried out at the Swedish University of Agricultural Sciences in AInarp, a comparison has been performed between ordinary potato pulp and pulp from the modified potato clone 92 527-1. Ordinary potatoes contain in their starch abodt 75% amylopectin and 25% amylose. In the GMO-potato arnylopectin constitutes nearly 100%. The aim of the study was to compare the feeding values of the two types of potato pulp when fed to 32 recruitment heifers of Swedish Friesian Breed (SLB) in a Latin square model. The heifers were between 13 and 19 months old at the start of the experiment, weighing between 402 - 545 kg. The model included two experimental periods of seven weeks and two groups, each of 16 heifers. In period 1 the heifers in group 1 were fed the GMO-pulp and group II the ordinary pulp. The pulp types were changed in period 2. After the changeover, the heifers were followed in a post-period of 4 weeks without feeding pulp.

The potato pulp was responsible for 31-32% of the total dry matter intake, or 2.1 - 2.6 kg of DM daily per animal &pending on body weight of the heifer. The body weight gain was followed and the feed consumption was registered individually. No statistically significant differences were observed due to type of potato pulp. The average daily weight gain **was 668 g for ordinary pulp and 646 g for GMO**pulp (p-value = 0.61, not significant). With the exception of two animals, the appetite on potato pulp was very good - independent of type. After the end of pulp feeding, the heifers seemed to long for it staring after the feed car. No influences of pulp type were observed on the animal health or consistency of manure.

(Note: Tbe summary in English has been copied directly from the original text of the Swedish report.)