Nutritional assessment of genetically modified rapeseed and potatoes, differing in their output traits

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Introduction

Substantial equivalence is widely accepted as assessment of feeds from genetically modified plants without changes in the composition. But this concept is not adequate for those with output traits, especially concerning their nutritive feeding value.The objective of this study is to evaluate rapeseed and potatoes belonging to the second generation of GM-plants.

Material and Methods

GM-rapeseed: Insertion of the acyl-thioesterase gene from *Cuphea lanceolata* into the genome of the cv. *Drakkar* with the aim, to increase in the fatty acid profile the percentage of myristic acid (13 vs. 0) and palmitic acid (20 vs. 4) at the expense of oleic acid (39 vs. 67).

GM-potato: Transfer of 2 transferase genes (1-SST and 1-FFT) of globe artichoke *„Cynara scolymus"* to the cv. *Desirée*, so that tubers represent the full artichoke inulin spectrum at a concentration of 5% in the DM.

Modified cultivars (transgenic) and parental lines (isogenic) were grown in 2003 at Federal Experimental Stations under the same growing conditions.

Processing: Rapeseed passed a roller crusher. Potato tubers were steamed and ensilaged in plastic silos.

Compositional assessment: Crude nutrients, macro elements, amino acids, rape glucosinolates and potato glycoalcaloides, using the official VDLUFA-methods.

Nutritional assessment: Feeding/digestibility trials with German hybrid pigs according to the guidelines of the Society of Nutrition Physiology (GfE).

Table 1: Experimental characteristics

	Rapeseed		Potato tubers
Feeding trial			
n	2x10		2x4
Live weight (kg)	32-67	67-105	49-78
Diet composition	grower	finisher	
Wheat (%)	35	37	8
Barley (%)	39	40	7
Potato protein (%)	7	5	4
Rapeseed (%)	15	15	-
Potato silage (%)	-	-	78
Min. Vit.-Suppl. (%)	4	3	3
Duration (d)	42	47	42
Digestibility trial			
n	5	5	4
Faeces collection (d)	7	7	7

Results

In Table 2 the content of nutrients, which contribute to the feeding value, are given for the transgenic feedstuffs in comparison to those of the parental cultivars.

Table 2: Chemical composition

	Rapeseed		Potato	
	Isogenic	Transgenic	Isogenic	Transgenic
DM	93.7	93.5	21.2	19.5
Proximates (% of DM)				
OM	95.8	95.3	94.5	94.2
CP	22.8	27.4	10.7	10.6
EE	47.9	44.0	0.6	0.6
CF	10.6	9.6	2.5	2.8
NfE	14.6	14.4	80.7	80.2
Starch	2.9	2.8	67.4	59.9
Sugar	4.4	4.5	-	-
Macro-elements (g/kg DM)				
Ca	4.39	4.19	0.51	0.56
P	7.36	8.41	2.10	2.20
K	6.27	8.29	19.60	20.00
Na	1.63	1.84	0.30	0.73
Mg	3.22	3.92	0.90	0.84
Amino acids (g/100g crude protein)				
Lysine	5.61	5.74	4.31	4.00
Methionine	1.86	1.97	1.18	1.39
Cystine	2.26	2.75	0.95	0.87
Threonine	4.31	3.99	2.49	2.53

Proximates, minerals and amino acids do not show significant differences due to the genetic modification. However, the starch content of the GM-potatoes is lower, indicating that their storage capacity of carbohydrates did not increase with the modification. The undesirable substances, which were analysed in the fresh, only freeze-dried material are summarised in Table 3.

Table 3: Contents of undesirable substances

	Glucosinolates (µmol/g DM)		
Rapeseed	**Total**	**Alkenyl GSL**	**Progoitrine**
Isogenic	13.2	9.0	7.1
Transgenic	20.4	15.4	12.1
	Glycoalkaloides (mg/kg DM)		
Potato	**Total**	**α-Chaconine**	**α-Solanine**
Isogenic	728	524	204
Transgenic	904	652	252

The results indicate that a substantial genetic modification might be associated with increased concentrations of undesirable substances, but in both cases they do not reach the safety limit.

Digestibility experiments

The genetic modification did not significantly influence the digestibility of the diets, when the rapeseed incorporation level was 15%. The energetic feeding value remained unaffected (Table 4).

Table 4: Nutrient content (% of DM), digestibility (%) and feeding value (MJ ME/kg DM) of the rapeseed based diets

	Isogenic		Transgenic	
	Crude nutrients	Digestibility	Crude nutrients	Digestibility
Grower diet				
OM	93.6	79.7	93.8	80.3
CP	20.6	82.6	22.2	83.2
EE	8.4	37.6	7.8	37.4
CF	6.0	42.2	5.9	44.5
NfE	58.6	88.6	58.0	88.6
ME	14.00		14.13	
Finisher diet				
OM	94.4	82.3	94.3	82.2
CP	18.8	85.1	19.7	84.4
EE	9.0	50.8	8.1	48.6
CF	5.5	35.6	5.5	40.4
NfE	61.1	90.3	61.0	90.0
ME	14.78		14.61	

The potato silage did not show a significant effect on digestibility due to the genetic modification, although CF-digestibility seemed to be depressed and NfE-digestibility increased. The energetic feeding value was 14.34 MJ ME/kg DM for the GM-silage as compared to 14.60 MJ ME/kg DM for the isogenic one.

In the feeding trials the results on zootechnical parameters correspond to those of the digestibility trials. No differences between the energy conversion ratio due to the use of iso- or transgenic rapeseed were detected, although the production level was found to be different. The lower production potential of the silage from transgenic potatoes was also confirmed in the feeding test.

Table 5: Production efficiency of transgenic rapeseed and potato silage as compared to the isogenic counterparts

	Rapeseed		Potato silage	
	Isogenic	Transgenic	Isogenic	Transgenic
ME-intake (MJ/d)	32.03	30.59	23.19	22.89
Live weight gain (g/d)	832	795	711	668
Energy conv. ratio (MJ/kg)	38.48	38.45	32.62	33.73

Conclusion

Although the modifications of the rapeseed and the potato were composition-related (the GM-rapeseed showed substantial differences in the fatty acid profile and the GM-potatoes in the carbohydrate fraction), the effect on their production potential was only marginal. However, these modifications were found to be associated with higher concentrations of undesirable substances.