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EFFECT OF THE DIETARY DRY GRAPE POMACE ON THE PERFORMANCE AND HEALTH STATE OF FATTENING STEERS

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Abstract

Potential source of nutrients and also a strong antioxidant, grape pomace is currently in the focus of the animal scientists. This 3 months trial used 14 Romanian Spotted fattening steers, with an average initial weight of 256 kg, assigned uniformly to two groups. The groups differed by the absence or presence of dry grape pomace in the compound feed, next to the bulk forage, alfalfa haylage. Feed intake of the two groups was similar both as concerns the bulk feed and as concerns the compound feed. The weight gain was also similar, 1306 g/steer/day in the control group (no dry grape pomace in the compound feed) and 1301 g/steer/day in the experimental group (20% dry grape pomace which replaced most of the barley used for the control group). The replacement of barley by dry grape pomace in the compound fed for fattening steers didn't have a significant influence on feed conversion ratio and feeding efficiency; no health problems were noticed either, as shown by the plasma profile of the experimental animals.

Key words: *steers, alfalfa haylage, dry grape pomace, feed intake, weight gain, feed conversion, biochemical profile*

INTRODUCTION

The dry grape pomace is one of the supplemental, or newly identified feed sources, with less known feeding potential that can be fed to ruminants. The dry grape pomace is a by-product from wine making, or from table grape processing. In a dry form, it can be preserved for a longer period, just like the hay Şerban, 2013); from a ton of fresh grape pomace result about 140-150 kg dry grape pomace (M. Bahcivanji et al., 2012), which is consumed with pleasure by the animals due to its sourish taste.

It appears that the volume of research on the dietary dry grape pomace is limited, both in Romania and worldwide, regarding the efficiency of nutrient utilization, the economics of feeding dry grape pomace and the health state of the animals treated with dry grape pomace as supplemental feed for ruminants.

The dry grape pomace is a true "mine" of resveratrol, one of the most powerful antioxidants identified so far, which has strong therapeutic properties. Resveratrol is found mainly in the skin and pulp of the red grapes. It is regarded as the most efficient natural cardiovascular protector, being 50 times more powerful than vitamin E. Recent studies conducted by researchers at Harvard University, USA, show that resveratrol, the magic antioxidant, changes considerably the quality and length of life. These scientific facts support the fact that grape pomace, a by-product from grape juice extraction, is actually a medicine with major health benefits.

The variation of the blood biochemical parameters can be used (Jain, 1986; Bush, 1991; Awah and Nottidge, 1998) to estimate the nutritional, physiological and pathological state of the animals; it can also be used to determine the influence of feeding, age, sex, housing, environment, stress and transportation on the animals both in tropical and in temperate regions (Ogunrinade et al., 1981; Bush, 1991; Ogunsanmi et al., 1994).

The grape pomace is given to animals mixed with other forages; its feeding value is rather modest, about half of the feeding value of the hay and it has a high level of hardly-digestible matter (Şerban, 2013). Starting from these facts, this experiment aimed to determine the effects produced by the dietary grape pomace given to fattening steers on animal performance and health state.

MATERIALS AND METHODS

The trial was conducted on Romanian Black Spotted (BNR) fattening steers with an average initial weight of 256 kg, assigned uniformly to a control group and an experimental group with

7 steer each. The diets were formulated according to the new IBNA system (Burlacu et al. 1991; 2002) of feeding value evaluation, and they were designed to have similar energy and protein levels. The diets consisted of alfalfa haylage as single bulk forage and a concentrate feed made of corn, barley, sunflower meal, monocalcium phosphate and salt (control diet). 82% of the barley was replaced by dry grape pomace in the formulation for the experimental group. A specific premix was used in both diets, adequate to the species and weight category, which provided a balanced supply of vitamins and minerals. Table 1 shows the compound feeds formulations.

Table 1. Compound feeds formulation (%)

Specification	Control	Experimental
Corn	33.00	40.00
Barley	24.50	-
Wheat	27.00	26.50
Dry grape pomace	-	20.00
Sunflower meal	12.00	10.00
Monocalcium phosphate	1.00	1.00
Salt	1.50	1.50
Premix	1.00	1.00
Total	100.00	100.00

The animals were housed in a fattening house for steers, in collective stalls with slatted concrete floors and with a feeding alley. Feed intake and the leftovers were measured. The animals had free access to the water supplied by constant level drinkers.

The experiments run for 91 days, which included a period of accommodation of the animals with the new diet formulations. During the actual experimental period we monitored daily the feed intake and the body weight (the animals were weighed in the beginning and at the end of the trial), and we calculated the average daily feed intake, feed conversion ratio and the economic efficiency of feeding.

At the end of the trial we collected blood samples from the jugular vein from the entire group of animals. The blood samples were assayed for blood sugar, cholesterol, triglycerides, DHL, LDL, total protein, albumin, total bilirubin, creatinine, urea, alkaline phosphatase, gamma globulin, LDH, creatine kinase, calcium, phosphorus, magnesium and iron, to determine the health status of the animals. All biochemical assays were performed with a semiautomatic **BS-130 Chemistry analyser** (Bio-Medical Electronics Co., LTD, China).

All data concerning animal performance and the biochemical assays were processed statistically; STAT VIEW: Anova and T Test were used to determine the significance of the differences between groups.

RESULTS AND DISCUSSIONS

The chemical composition of the feed ingredients was determined with the modified Weende design (Criste et al., 2003). The alfalfa haylage had 526 g DM, 121 g CP, 357 g CF and 17.39 MJ GE per 1000 g DM. The compound feed ingredients (Table 2) had the following chemical composition (g/kg DM): protein – 88 g for corn, 104 g for barley, 124 g for wheat, 158 g for the dry grape pomace and 358 g/kg DM for the sunflower meal; crude fibre – 35 g for corn, 85 g for barley, 36 g for wheat, 292 g for the dry grape pomace and 229 g/kg DM for the sunflower meal. Research by Bahcivanji et al., 2012, show quite similar values with our findings for the chemical composition of the dry grape pomace for most nutrients. Comparable values were also reported in the recent paper by Coşman et al., 2012.

The chemical composition of the compound feed which included 20% dry grape pomace had several difference in the organic components compared with the control compound feed. These differences were due to the different amount of barley (24.50%) in the formulation of this compound feed, as shown in the table below.

Table 2. Chemical composition of the feed ingredients and of the compound feed (g/kg feed/1000 g DM)

Item	DM	OM	CP	EE	CF	NFE	Crude ash	GE (MJ)
Alfalfa haylage	526 1000	473 899	64 121	9 17	188 357	212 404	53 101	9.17 17.39
Corn	850 1000	837 985	75 88	29 34	30 35	703 828	13 15	15.50 18.23
Barley	890 1000	867 974	93 104	15 17	76 85	683 768	23 26	15.92 17.89
Wheat	908 1000	888 978	113 124	20 22	33 36	722 796	20 22	16.41 18.07
Dry grape pomace	812 1000	735 905	128 158	27 33	237 292	77 95	343 422	14.56 17.93
Sunflower meal	890 1000	826 928	319 358	15 17	204 229	288 324	64 72	17.01 19.11
Compound feed, control	922 1000	881 956	126 137	16 17	93 101	646 701	41 44	16.43 17.83
Compound feed, experimental	928 1000	886 955	108 116	20 22	110 119	647 697	42 45	16.55 17.83

The chemical composition date were used to calculate the feeding value of the feed ingredients and of the compound feeds (with and without dry grape pomace), expressed in meat feed units (mFU), IDPN (intestinally digestible protein allowed by nitrogen supply), IDPE (intestinally digestible protein allowed by energy supply), calcium (Ca) and phosphorus (P), as shown in Table 3. The energy and protein feed values of the studied forages and of the compound feeds are generally within the range of values admitted by the literature (Burlacu et al., 2002).

Table 3. Calculated feeding values of the dietary ingredients and of the compound feeds

Item	DM (g/kgDM)	mFU /kg DM	IDPN (g/kg DM)	IDPE (g/kg DM)	Ca (g/kg DM)	P (g/kg DM)
Alfalfa haylage	526	0.62	77	70	12.38	3.75
Corn	850	1.54	70	121	1.02	4.48
Barley	890	1.26	67	90	1.02	4.39
Wheat	908	1.54	82	103	1.02	5.01
Dry grape pomace	812	0.78	102	88	7.35	3.84
Sunflower meal	890	0.79	231	119	4.03	12.61
Monocalcium phosphate	900	-	-	-	380	-
Salt	900	-	-	-	-	-
Premix	900	1.3	80	100	0.20	2.40
Compound feed. control	922	1.27	94	107	7.89	8.49
Compound feed. experimental	928	1.16	80	98	8.93	7.93

Throughout the experimental period we measured on a daily basis the feed intake and the leftovers for each group of animals, expressed both in gross kg, and in dry matter, thus showing the proportion of the compound feed (Table 4). The feed intake was rather similar in both groups, both as proportion of the bulk feed (alfalfa haylage) and of the concentrate feed (CF) taken as such or as dry matter. For instance, the intake of alfalfa haylage (free access) was 11.56 kg/steer/day for group C and 12.49 kg for group E, or 6.08 and 6.57 kg DM/steer/day, respectively. The differences were not statistically significant, as shown in the table below.

Table 4. Average daily feed intake (kg/steer/day and kg DM/steer/day)

Item	Romanian Black Spotted steers	
	Control	Experimental
Alfalfa haylage – gross Compound feed – gross	11.56 3.74	12.49 3.76
Alfalfa haylage – DM Compound feed – DM Total DM	6.08 3.46 9.54	6.57 3.48 10.05
Bulk forage of the total DM (%)	63	65
Compound feed of the total DM (%)	37	35

The estimated feeding values and the feed intake were used to determine the daily supply of major nutrients (energy, protein, calcium and phosphorus) and how much were they supplied related to the feeding norms; this was estimated according to the average body weight, average daily weight gain and nutrient supply of the diets (Table 5). There were very small differences between groups in terms of energy and protein supply. Thus, the animals from the control group consumed in average on a daily basis 8.16 mFU, 780.40 g IDPN and 750.95 g IDPE, while the animals from the experimental group consumed in average on a daily basis, 8.11 mFU, 810.17 g IDPN and 779.88 g IDPE. This shows that the energy supply of the diet met the energy requirement of the animals from the two groups (C and E) in a very similar proportion (102.15 – 102.79%); this was valid for too IDPN (115.44 – 119.85%) and IDPE (111.09 – 115.37%).

On the other hand, the situation was different concerning the supply of calcium and phosphorus salts, which increased (not significantly, however) in both groups, oscillating between 100.23% and 113.78% for calcium, and between 117.75 and 118.41% for phosphorus, but in general, the results fall within the range of values reported by the literature.

Table 5. Nutrient supply of the diets and how much of the requirement was met

Item	mFU	IDPN (g)	IDPE (g)	Ca (g)	P (g)
Control					
Dietary supply	8.16	780.40	750.95	56.03	38.24
Requirement	7.94	676	676	52.91	32.29
Supply/requirement (%)	102.79	115.44	111.09	100.23	118.41
Experimental					
Dietary supply	8.11	810.17	779.88	60.20	38.02
Requirement	7.94	676	676	52.91	32.29
Supply/requirement (%)	102.15	119.85	115.37	113.78	117.75

The recorded feed intakes were used to calculate the average daily weight gains, which were similar for both groups (1306.12 g for group C and 1301.41 g for group E). Table 6 shows that animal performance resembled in both groups (group C with no dry grape pomace treatment and group E where the 20% dry grape pomace replaced completely the barley.

Table 6. Body weight gain and average daily weight gain*

Item	Romanian Black Spotted steers	
	Control	Experimental
Average initial weight (kg)	250.86±38.98	255.00±23.22
Average intermediary weight	306.43±44.49	313.14±23.59
Average final weight (kg)**	369.714±35.76	373.86±23.27
Total gain (kg/steer)	118.85	118.43
ADG (g/steer)**	1.306.12[a]±136.80	1.301.41[a]±66.83

*means plus standard deviation

** non-significant differences between groups (P≥0,05)

Feed conversion, correlated with animal performance, expressed in dry matter (DM) meat feed units (mFU), IDPN (intestinally digestible protein allowed by nitrogen supply), IDPE (intestinally digestible protein allowed by energy supply), shows that the experimental group used slightly higher amounts of DM (7.54 kg), mFU (6.26), IDPN (621.00 g) and IDPE (601.00 g) compared to the control group (7.13, 6.18, 593.00 and 571.00, respectively), which means that the experimental group made a poorer use of the dietary energy and protein to make one kg of gain, compared to the control group, as shown in Table 7.

Table 7. Feed conversion ratio

Item	Romanian Black Spotted steers	
	Control	Experimental
Kg DM/kg gain	7.13	7.54
mFU/kg gain	6.18	6.26
g IDPN/kg gain	593.00	621.00
g IDPE/kg gain	571.00	601.00

Analysing the expenditure with animal feeding, expressed in lei/steer/day and in lei/kg gain (Table 8) we may notice that the diet with dry grape pomace didn't improve feed conversion ratio and didn't make the conversion more efficient. The cost of feeds per kg gain is just 0.9% higher in the experimental group compared to the control group, correlated with a slightly lower average daily weight gain and, implicitly, a slightly higher feed conversion ratio in the experimental group, but with no significant difference, however.

Table 8. Feeding cost

Item	Romanian Black Spotted steers	
	Control	Experimental
Lei/animal/day	3.334	3.352
Lei/kg gain	2.553	2.576
Cost lei/kg gain - % compared to the control	100	100.9

The health state of the animals, shown by the blood plasma concentration of glucose, cholesterol, triglycerides, HDL and LDL, shows normal values for the particular species and category of production. Statistically, as shown in Table 9, the differences are significant ($P \leq 0.05$), both the cholesterol and for the HDL (high density lipoproteins, the "good" cholesterol), with higher levels for the dry grape pomace treatment. These differences are due to the structural particularities of the fat from the dry grape pomace, also associating the fact that a higher amount of dietary fat leads to a higher level of serum cholesterol (Abrams, 1980). On the other hand, the differences for the values recorded for glucose and triglycerides are not significant ($P \geq 0.05$). Highly significant ($P \leq 0.001$) differences were noticed for the LDL (low density lipoproteins, the "bad" cholesterol), the control group recording higher values than the experimental group, but, nevertheless, within the normal limits allowed for this species of animals.

Table 9. Plasma energy profile of the fattening steers*

Parameters	Control	Experimental (grape pomace)	Value of P
Glycaemia (mg/dL)**	69.94 ± 12.71	71.70 ± 7.91	0.7557
Cholesterol (mg/dL)***	86.73 ± 23.84	129.59 ± 29.91	0.0118
Triglycerides (mg/dL)**	13.64 ± 5.30	10.01 ± 1.80	0.1119
HDL direct (mg/dL)***	46.57 ± 16.55	73.57 ± 16.00	0.0091
LDL (mg/dL)****	38.29 ± 2.16	17.82 ± 8.45	0.0001

*means and standard deviation
**not significant differences between groups ($P \geq 0.05$)
***significant differences between groups ($P \leq 0.05$)
****highly significant differences between groups ($P \leq 0.001$)

Table 10 shows that the plasma protein profile (total protein, albumin, total bilirubin, creatinine and urea) falls within the range of normal physiological values for these parameters and for the category of the experimental animals, being very similar with the results reported by Kaneko et al., 1997. Only for urea the difference is significant (P≥0.05), with higher values for the experimental group compared to the control group, knowing that the concentration of serum urea can be influenced by the diet formulation too (Royakkers, 2011).

Table 10. Plasma protein profile of the fattening steers *

Parameters	Control	Experimental (grape pomace)	Value of P
Total protein (g/dL)**	6.76 ± 1.57	6.99 ± 0.72	0.7231
Albumin (g/dL)**	3.80 ± 0.50	4.11 ± 0.33	0.1974
Total bilirubin (mg/dL)**	0.35 ± 0.12	0.36 ± 0.11	0.8044
Creatinine (mg/dL)**	1.01 ± 0.35	1.18 ± 0.21	0.2694
Urea (mg/dL)***	13.71 ± 4.27	20.14 ± 3.19	0.0077

*means and standard deviation
**not significant differences between groups (P≥0.05)
***significant differences between groups (P≤0.05)

Plasma mineral profile. The parameters of the plasma mineral profile generally range within the normal limits both for the control and for the experimental group. Thus, the concentration of serum calcium is within the normal physiological limits for the age and weight category of the animals in both groups. The concentration of serum magnesium, however, exceeded the normal physiological limits (1.5- 2.9 mg/dL) reaching the value of 4.00 mg/dL in the control group, possibly due to the dry grape pomace, existing a trend to influence the reference values (P>0.05 up to 0.10). Knowing that in the young animals, the bones are more vascularized and the mineral exchange is more intense, with higher values of the plasma magnesium, we think that this is the situation from our experiment, as shown by the table below. The plasma phosphorus concentration ranged within the normal physiological range for both groups of animals, with slightly (but not statistically significant) higher values for the control group. The serum iron concentration too falls within the normal physiological values for the age and category of animals in both groups, which confirms that iron acts synergistically with magnesium.

Table 11. Plasma mineral profile of the fattening steers *

Parameters	Control	Experimental (grape pomace)	Value of P
Calcium (mg/dL)**	9.72 ± 3.45	10.25 ± 1.20	0.7100
Phosphorus (mg/dL)**	6.47 ± 1.54	7.34 ± 0.56	0.1829
Magnesium (mg/dL)***	1.94 ± 0.26	4.00 ± 2.56	0.0555
Iron (ug/dL)**	1489.53 ± 170.89	1413.79 ± 238.90	0.5080

*means and standard deviation
**not significant differences between groups (P≥0.05)
***P>0.05 up to 0.10 = trend to be influenced

Plasma enzyme profile. The common characteristics of the enzymatic compounds are rather variable because of the instability of the blood biochemical indicators, as shown by Şogorescu et al., 2008. However, the concentration of transaminases (alkaline phosphatase, Gama GT and creatine kinase), indicators of the liver function, revealed normal values for the category of steers used in the experiment. In this case too, same as with the magnesium concentrations, there is a trend of influence on the reference values (P>0.05 to 0.10) for the alkaline phosphatase in the group treated with dry grape pomace (Table 12).

Table 12. Plasma enzyme profile of the fattening steers*

Parameters	Control	Experimental (grape pomace)	Value of P
Alkaline phosphatase (U/L)***	67.94 ± 28.90	93.77 ± 22.61	0.0872
Gama GT (U/L)**	14.84 ± 6.07	13.54 ± 3.36	0.6292
Creatine kinase (U/L)**	397.14 ± 177.66	381.71 ± 154.59	0.8653

*means and standard deviation

**not significant differences between groups (P≥0.05)

***P>0.05 up to 0.10 = trend to be influenced

CONCLUSIONS

- The inclusion of 20% dry grape pomace in the compound feeds for fattening steers, replacing most of the barley (82%) used for the control group, didn't influence CF intake or the total feed intake (compound feeds + alfalfa haylage). The resulting weight gains were rather similar in the control (no grape pomace) and the experimental (dry grape pomace treatment) groups, the differences not being statistically significant (P≥0.05): 1306 g/steer/day for the control group and 1301 g/steer/day for the experimental group.
- The replacement of the barley by dry grape pomace in the compound feeds for fattening steers didn't yield any significant differences in terms of feed conversion ratio, feeding efficiency and it didn't cause any health problems in the experimental animals, as shown by the determinations of the biochemical parameters from the blood plasma of the animals.

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