Nutritive value of broad-leaved dock (*Rumex obtusifolius* L.) and its effect on the quality of grass silages

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ABSTRACT: The effect of broad-leaved dock (*Rumex obtusifolius* L.) on the impaired nutritive value of grassland herbages was studied together with the effect of dock and addition of microbial inoculant on the fermentation process in grass silages. The herbage of broad-leaved dock exhibits low DM content, CP and fibre contents comparable with red clover, yet its NEL concentration is low. Quality of silages made of dock at DM content over 300 g/kg is good but the silages show significantly lower contents of lactic acid (35.9%), acetic acid (70.0%) and higher pH values (4.69 vs. 4.35) as compared with the grass silage. Silages made of dock do not contain butyric acid and exhibit lower rates of proteolysis. The presence of broad-leaved dock in herbage poses a danger of slow wilting and low production of fermentation acids. The addition of lactic acid bacteria (LAB) showed in the studied set of silages and in dock silages by an increased content of lactic acid (+18.9% and +27.0%, resp.) and by a significant reduction of pH value (–0.17 and –0.14, resp.).

Keywords: broad-leaved dock; nutritive value of herbage; ensiling; fermentation

Broad-leaved dock is together with creeping thistle (*Cirsium arvense* (L.) Scop.) and dandelion (*Taraxacum officinale* Wigg.) one of the most frequently occurring grassland weeds in the Czech Republic (Martinková and Honěk, 2001). Broad-leaved dock belongs to the group of plants with the highest requirement for nitrogen and other nutrients. Its ecological requirements and herbage quality differ only little from those of curled dock (*Rumex crispus* L.) and the two species can therefore be assessed together (Weissbach, 1998). According to Klimeš (1993), there are also unfertile hybrids of the two species occurring in grass stands, referred to as *R.* ×*pratensis*. These species represent aggressive plants which force cultural grasses and legumes out from their surroundings and cause problems at herbage conservation due to their low DM contents. Humpreys *et al*. (1999) demonstrated that grazed swards in Britain were related to a higher mortality of docks as compared with mown swards due to lower doses of applied fertilisers, increased defoliation and trampling. High doses of N-fertilisers were put into connection with higher occurrence of *Rumex obtusifolius*. Novák (1994) described associations with dominating broad-leaved dock at grazing sites overfertilized with animal excrements, which can be long without any change in the species composition and which are avoided by grazing animals. In the system of organic agriculture the broad-leaved dock is a very serious problem as it cannot be controlled by herbicides and docks markedly reduce the sward nutritive value (Pötsch, 2000).

With respect to the fact that sward herbages are fed on most farms in the form of grass silages, it is vitally important to know individual factors affecting their nutritive value and also the quality of fermentation process during their production. It was shown (Harrison and Johnson, 2001; Sommer and Petrikovič, 2003) that the quality of preserved

The results were obtained and processed under the financial support of the Ministry of Education, Youth and sports of the Czech Republic (Project No. 432100001).

fodders is decisive not only for total DM intake and productivity of animals but also for the health condition of dairy cows. The main technological reason for the worse quality of fermentation is usually inadequate DM content, long wilting period and unsuitable ensiling additive (Kalač and Míka, 1977).

The goal of this paper was to assess the influence of the proportion of broad-leaved dock in herbage and the effect of the application of microbial inoculant with strains of lactic fermentation homofermentative bacteria (*Lactobacillus rhamnosus* and *Enterococcus faecium*) as active substances on the process of fermentation and on the nutritive value of silage from wilted sward with a proportion of dock and silage made of dock herbage itself. Another goal was to evaluate the effect of dock on the reduction of sward herbage nutritive value.

MATERIAL AND METHODS

A model experiment was established with wilted sward herbage to determine preservation effects of ensiling additive and broad-leaved dock on the process of fermentation. The ensilaged herbage originated from the 2nd cut of permanent sward harvested on 24 July 2001. The herbage was supplied from the Research Station of Grassland Management and Forage Crops in Vatín. Grasses dominating in the silage were meadow fescue (*Festuca pratensis* Huds.), red fescue (*Festuca rubra* L.), cock's foot (*Dactylis glomerata* L.), from legumes only white clover (*Trifolium repens* L.) was present, other forb species such as ribwort (*Plantago lanceolata* L.) and common yarrow (*Achileum millefolium* L.). The wilted herbage was cut on a stationary chopper into pieces of theoretical length from 40–60 mm. Prior to being placed into the silo, the experimental variant was treated with an inoculant composed of homofermentative strains of lactic fermentation bacteria *Lactobacillus rhamnosus* and *Enterococcus faecium* (hereinafter LAB) at 1 g of dry preparation (1.10^{11} CFU) per 1 000 kg herbage in the form of aqueous solution. The silages were placed into experimental containers of 50 litres in volume. The fermentation process occurred in laboratory conditions at temperatures ranging from 20–25°C. After a thorough ramming of their contents the containers were air-sealed with a lid and their brims were covered up with the aqueous solution of molasses. The silages were opened and analysed after 70 days of storage in order to measure standard qualitative fermentation characteristics and basic parameters of nutritive value. The total number of experimental silages analysed and evaluated after the fermentation was 6 variants at six replications. Oxalic acid was determined by the method of extraction in HCl, precipitation with $Ca(COO)_2$ and titration with $KMnO_4$ according to Davídek *et al*. (1977). The analyses were made in the laboratories of S.O.S. Skalice nad Svitavou. The NEL value of silages and herbage was predicted by the *in sacco* method. The results were statistically evaluated by the analysis of variance and processed by Tukey's test using the Statgraphics 7.0 statistic programme.

In order to compare the nutritive value of broad-leaved dock, a sample of herbage was taken at the locality Jindřichov u Hranic, collected 6 weeks after the 1st cut from a permanent sward together with the herbage of red clover. The two samples were measured for the content of basic nutrients, the analyses serving to add data on the quality of broad-leaved dock herbage.

RESULTS AND DISCUSSION

Herbage quality

DM content of broad-leaved dock is generally known to be very low. With respect to former experience, the dock herbage wilting was made artificially in a drier. The grass herbage reached a desired DM content in the open within 24 hours. A very low DM content in dock forage was also found by Derrick *et al*. (1993) – 114 g/kg, and by Bockholt and Kannewurf (2001) – from 130 g/kg (whole month of May) to 270 g/kg at the end of July. The DM content of harvested dock herbage is markedly affected by the level of fertilization. Hatcher *et al*. (1997) detected 185 g DM in unfertilized plants, and DM content in fresh herbage below 100 g/kg at a higher level of fertilization with NH_4 ions.

It follows from the results presented in Table 1 that broad-leaved dock fresh herbage contains somewhat more fibre, ash and rumen-degradable proteins but markedly lower concentrations of net energy for lactation (NEL), WSC and Ca. The dock green forage exhibited a much higher concentration of potassium (by 46.8%) than the clover forage. The tetanic ratio of K/Ca + Mg (calculated as milligram equivalents) reaches the value by 58.8% higher in dock herbage than in clover forage, being still

Table 1. Nutritive value and substance contents in the dry matter of *Taraxacum officinale* and *Rumex obtusifolius* harvested at a stage of leaf rosette (Bohner, 2001) and *Trifolium pratense* as compared with *Rumex obtusifolius* herbage, 2nd cut, 6 weeks after 1st cut, permanent grassland, Jindřichov u Hranic (Hejduk, unpublished)

Parameter		According to Bohner (2001)		Hejduk (unpublished)	
		dandelion leaves	dock leaves	red clover	dock
Crude protein	g/kg	210.0	294.0	191.0	193.7
RDP (N degr)		–	–	140.1	152.6
Crude fibre	g/kg	121.0	107.0	238.2	261.5
Ash	g/kg	94.0	101.0	88.9	105.0
NEL	MJ/kg	–	–	5.76	4.82
WSC	g/kg	74.0	30.0	48.3	20.8
Ca	g/kg	9.30	5.40	10.98	7.66
P	g/kg	3.60	4.80	2.83	4.31
Na	g/kg	0.47	0.22	0.12	0.22
K	g/kg	25.30	37.40	28.76	42.23
Mg	g/kg	4.80	4.90	2.96	4.49
K/Ca + Mg		0.75	1.42	0.93	1.44
Oxalat	g/kg	1.30	6.80	0	9.3

RDP = rumen degradability of proteins, WSC = water soluble carbohydrates, NEL = net energy for lactation

below the critical value of 2.2 (Pavlů, 1994). Dock forage content of oxalic acid (9.30–41.1 g/kg) can be considered low, far from the value of potentially hazardous plants (100 g/kg DM) (Kalač and Míka, 1997). Excessive oxalic acid in the animal body impairs Ca utilization reducing digestibility of cellulose at the same time. Hatcher *et al*. (1997) pointed out that the content of total oxalate could range from 50–180 g/kg DM, which was much more than our results. They used the method of Cooke and Sansum (1976) as modified by Hatcher *et al*. (1995). This assay is based on the reduction in colour of the zirconium/3, 4-dihydroxyazobenzene 2′-carboxylic acid (DAC) complex by oxalic acid.

It is obvious from Tables 1 and 2 that the quality of forage at early growth stages exhibits favourable feeding parameters as far as it is evaluated only according to the contents of fibre and crude protein. These parameters are usually fitted for the basic quality evaluation in cultivated grasses and forage legumes, where they correlate with NEL very well (Pozdíšek, 1997). However, the simple correlations have a limited validity in wild herbage plant species of grass stands (Scehovic, 2002). According to this author, a herbage plant rich in proteins with the low content of lignified structural carbohydrates does not necessarily have to be adequately digestible at all times (which relates to the NEL value) and even less ingested by animals (feeding value). The phenomenon is typical of broad-leaved dock. Potential digestibility of dock computed from the ratio and from the digestibility of cell walls (true DM digestibility) was high (by 3% abs. higher than in ryegrass) but its actual digestibility (*in vivo*) was by 20% lower (Derrick *et al*., 1993). According to Tilley and Terry (1963), digestibility *in vitro* (48.2 to 62.2%) well corresponded with digestibility *in vivo* (50.3–59.5%). Digestibility of dock is apparently impaired by chemical or other factors which prevent to reach the potential digestibility.

Digestibility of broad-leaved dock forage measured by the *in vivo* method is low the fact being given by the presence of a number of anti-quality substances. Stählin (1971, in Weissbach, 1998) claims that the reason for the low quality of dock forage is a high content of free oxalate, potassium

Table 2. Nutritive value of analysed ensilages, 2nd cut, Vatín 2001

Parameter	Pure *Rumex* herbage		50% *Rumex* + 50% grassland herbage		Grassland herbage	
	without	with LAB	without	with LAB	without	with LAB
Dry matter (g/kg)	328.5	325.6	331.6	334.3	300.0	289.1
Crude protein (g/kg DM)	207.8	211.0	181.2	192.1	157.2	172.1
N-NH_3 (%) out of total N	5.87	6.54	7.44	6.98	7.38	7.00
Crude fibre (g/kg DM)	205.6	199.6	248.6	240.8	242.0	255.9
Ash (g/kg DM)	141.9	143.5	112.1	118.8	85.8	99.4
N free extract (g/kg DM)	412.7	414.0	418.0	408.3	465.0	422.6
NEL (MJ/kg DM)	4.46	4.45	4.98	4.93	5.54	5.45
Ca (g/kg DM)	8.72	8.97	8.10	8.55	6.93	8.38
P (g/kg DM)	4.04	4.30	3.65	3.91	2.88	2.73
Na (g/kg DM)	0.22	0.22	0.11	0.22	0.11	0.11
K (g/kg DM)	46.93	47.09	36.63	38.85	22.77	28.16
Mg (g/kg DM)	4.25	4.71	3.33	4.11	2.31	2.79
Oxalic acid (g/kg DM)	41.1	38.6	18.1	19.6	0.0	0.0

LAB = Lactic Acid Bacteria

hydrogenoxalate, alkaloids, resins and tannic acids. According to Hatcher *et al*. (1997), the content of anti-quality substances, particularly oxalates and nitrates, in dock plants was increased by the fungus *Uromyces rumicis* and by fertilization. Young leaves contain the highest amount of crude protein but the lowest amount of nitrates and oxalates in all plant parts and are therefore most valuable in terms of nutrition. It is these youngest leaves that become a focus of attention for the herbivorous beetle *Gastrophysa viridula* during its oviposition and feeding. Derrick *et al*. (1993) are of an opinion that the increased content of anti-quality substances in the dock leaves is a natural protection of the plant against the herbivores.

Komárek and Pozdíšek (2001) studied the inhibition effect on the development of gases, which correlates with digestibility, in 10 species of meadow forbs at Vitrogest facility. The strongest inhibition effect was that of broad-leaved dock which reduced the development of gases by 35.0% and 22.0% when its proportion in the mixture with forage legumes was 50% and 25%, respectively.

Bockholt and Kannewurf (2001) studied changes in the broad-leaved dock herbage quality in northern Germany during ageing in the 1st growth. The concentration of crude proteins in herbage amounted to 325 g/kg DM in the first week of May and 225 g/kg DM after 4 weeks. Fibre concentrations in leaves ranged from 120–150 g/kg DM and those in stems showed an increase with ageing from 130–380 g/kg. Forage digestibility decreased (cellulase method) from 76% (20 May) to 60% (20 July) in leaves and 40% in stems. Energy concentration expressed by NEL decreased from 6.7 (7 May) through 6.0 (25 May) down to 3.1 MJ/kg DM (20 July).

Derrick *et al*. (1993) found that the fresh forage of broad-leaved dock was accepted by sheep considerably worse than wilted or dry forage. The voluntary intake of dried dock was satisfactory (72.4–78.6 g/kg $W^{-0.75}$), but the intake of fresh forage was low, especially if the forage was chopped. There is likely a factor that manifested itself in palatability and odour particularly after the forage was chopped. According to farming practice in the Czech Republic, the cattle also accept the cut and wilted dock after topping although the uncut plants remain ignored.

With respect to the contents of mineral elements, all analyses (Tables 1, 2) exhibit a high K content which markedly exceeds the concentration recommended for forage to feed to animals (30 g/kg DM). As compared with other species (Tables 1, 2), broad-leaved dock contains by 46–66% K more. This element always occurs in forage at concentrations markedly higher than the requirements of animals. This is why a further increase in K concentration in forage may result in health problems. On the other hand, the above analyses corroborated a favourable increase in Mg concentration in forage recorded by Wilman and Riley (1993), who point out that a higher Mg content may be favourable in forage but at the same time a high content of K-ions may restrict its absorption. The Mg content was by 51–60% higher (Tables 1, 2) than in grass herbage. The content of phosphorus was also conspicuously higher (by 33–52%) than in the comparable herbage. The Ca content was relatively low and comparable with grasses but lower than in white clover and dandelion (Wilman and Riley, 1993).

Conclusive for herbage quality is however the productivity of animals (Míka *et al*., 1997). Gains of wethers were lowest when the animals were fed dock and amounted to mere 47–110 g/day, which was only 53.6%–65.2% as compared with leafy perennial ryegrass (Derrick *et al*., 1993).

Influencing the process of fermentation in grass silages

References to the quality of fermentation process in silages with dock are considerably less numerous than those dealing with the nutritive value of docks. One of the most comprehensive studies is that published by Weissbach (1998). According to his findings the content of nitrates and the colonization by epiphytic bacteria of lactic fermentation in broad-leaved dock are markedly below the threshold of silages without butyric acid. However, the silages made of dock always remain without butyric acid (as well as in our experiment). Another remarkable phenomenon relates to the very low proportion of ammonia in the total N-content of silage. According to Weissbach (1998), dock silages had only 1.1–2.9% N-NH_3 of total N. According to Weissbach and Honig (1992), grass silages with N-NH_3 up to 10% are classified best. It follows from the results of our experiments (Table 2: 5.9–6.5% N-NH_3 in dock silages, which is only by 0.5–1.5% less than in comparable grass silages) that the effect of dock on the indicator is insignificant. However, Weissbach (1998) ensilaged unwilted dock with an initial DM content being 135 g/kg fresh herbage. It follows from the results presented in Table 2 that the inoculation did not result in any pronounced changes of proteolysis. It shows that the course of fermentation itself did not significantly affect the content of energy, which corresponds well with the conclusions of other authors (Jambor *et al*., 1995).

Weissbach (1998) measured fresh dock herbage for the following parameters: cell sap pH 4.5–4.8; Z/PK coefficient 4.1–4.8; nitrates 0.2–0.4 g/kg DM.

Our findings indicate that the most serious problem at ensilaging herbage with a higher proportion of docks consists in the low content of dry matter, which results from difficult wilting as compared with grasses. Our former (unpublished) experiments demonstrated that dry matter reached by grassland herbage after 24 hours of wilting was 33.2–34.3% while that recorded in dock was only 16.4–17.3%.

It follows from the results in Table 3 that silage made of dock after wilting to dry matter comparable with grassland herbage (Table 2) exhibits significantly lower contents of lactic acid (35.9%), acetic acid (70.0%) and total acids (43.1%) as compared with grass silages, a significantly higher pH value (4.69 vs. 4.35), and significantly lower titratable acidity (TA) (82.8%). The above-mentioned silages contained no butyric acid. The lactic acid/acetic acid ratio was also significantly lower (1.93 vs. 3.73). The effect of inoculant (LAB) showed in dock silage by increased lactic acid content and total acids, and by decreased pH (Table 4). The higher pH value and lower titratable acidity in dock silages were caused by low WSC content and higher content of alkali K and Mg.

The effect of LAB inoculation showed in the set of all silages by significantly increased contents of

Table 3. Effect of herbage crop on the process of fermentation

Herbage	LA	AA	SA	pH	Ethanol	LA/AA	TA to pH 8.2
	(g/kg DM)				(g/kg DM)		(mg KOH/100 g)
Rumex obtusifolius	33.1[a]	17.3[a]	50.4[a]	4.69[a]	4.8[a]	1.93[a]	1 103.5[a]
50% *R. obtusifolius* + 50% grass	79.3[b]	19.1a	98.4[b]	4.45[b]	4.5[a]	4.20[b]	1 276.3[b]
Grassland herbage	92.3[b]	24.7[b]	117.1[c]	4.35[b]	4.7[a]	3.73[b]	1 334.4[b]

Table 4. Results of fermentation process in the respective silages

Herbage	Treatment	LA (g/kg DM)	AA (g/kg DM)	SA (g/kg DM)	pH	Ethanol (g/kg DM)	LA/AAt	TA to pH 8.2 (mg KOH/100 g)
Rumex obtusifolius	without inoculant	29.2	17.6	46.8	4.69	6.2	1.66	1 149
	inoculant	37.1	17.1	54.2	4.55	3.4	2.17	1 058
50% *R. obtusifolius* + 50% grass	without inoculant	74.2	19.8	94.0	4.47	4.6	3.75	1 186
	inoculant	84.5	18.3	102.8	4.29	4.4	4.62	1 366
Grassland herbage	without inoculant	83.7	24.0	107.7	4.39	4.6	3.49	1 306
	inoculant	101.0	25.2	126.2	4.3	4.8	4.01	1 363

Table 5. Effect of LAB inoculation on the process of fermentation

Variant	LA (g/kg DM)	AA (g/kg DM)	SA (g/kg DM)	pH	Ethanol (g/kg DM)	LA/AA	TA to pH 8.2 (mg KOH/100 g)
Without inoculant	62.4[a]	20.4[a]	82.8[a]	4.58[a]	5.1	2.99[a]	1 214[a]
Inoculant	74.2[b]	20.3[a]	94.5[b]	4.41[b]	4.2	3.58[b]	1 262[b]

LA = lactic acid, AA = acetic acid, SA = sum of acids, TA = titratable acidity (mg KOH/100 g silage)
[a, b, c] = significant differences at a significance level of 95%

lactic acid (+18.9%) and total acids (+14.1%), significantly lower pH value (–0.17), significantly higher lactic acid/acetic acid ratio, and by significantly higher TA (Table 5).

With respect to the evaluation of the fermentation process (Weissbach and Honig, 1992) in the respective silages (Table 3), the silages were classified as excellent with the exception of dock silages whose classification was worse due to the lower content of acetic acid (below 20 g/kg DM) and higher pH (above 4.5).

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Received: 03–07–29
Accepted after corrections: 04–03–18

ABSTRAKT

Nutriční hodnota šťovíku tupolistého *(Rumex obtusifolius L.)* a jeho působení na kvalitu travních siláží

Byl zjišťován vliv šťovíku tupolistého *(Rumex obtusifolius L.)* na zhoršení nutriční hodnoty píce travních porostů. Dále byl hodnocen vliv šťovíku a přídavku mikrobiálního inokulantu na kvasný proces travních siláží. Píce šťovíku tupolistého vykazuje nízký obsah sušiny, obsah NL a vlákniny je srovnatelný s jetelem lučním, ale přesto má nízkou koncentraci energie NEL. Kvalita siláží vyrobených ze šťovíku při obsahu sušiny nad 300 g/kg je dobrá, ale siláže vykazují průkazně méně kyseliny mléčné (35,9 %), kyseliny. octové (70,0 %) a vyšší pH (4,69 vs. 4,35) ve srovnání s travní siláží. Siláže vyrobené ze šťovíku neobsahují kyselinu máselnou a vykazují nižší podíl proteolýzy. Přítomnost šťovíku tupolistého v píci představuje riziko pomalého zavadání a nízké produkce kvasných kyselin. Přídavek bakterií mléčného kvašení se projevil v souboru sledovaných siláží zvýšením obsahu kyseliny mléčné (+18,9 % resp. +27,0 %) a průkaznou redukcí hodnoty pH (–0,17 resp. –0,14).

Klíčová slova: šťovík tupolistý; nutriční hodnota píce; silážování; fermentační proces

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