

ÚSTAV ZEMĚDĚLSKÝCH A POTRAVINÁŘSKÝCH INFORMACÍ

Czech Journal of
ANIMAL SCIENCE

ŽIVOČIŠNÁ VÝROBA

ČESKÁ AKADEMIE ZEMĚDĚLSKÝCH VĚD

11

VOLUME 43
PRAGUE
NOVEMBER 1998
CS ISSN 1212-1819

CZECH JOURNAL OF ANIMAL SCIENCE

An international journal published under the authorization by the Ministry of Agriculture and under the direction of the Czech Academy of Agricultural Sciences

Mezinárodní vědecký časopis vydávaný z pověření Ministerstva zemědělství České republiky a pod gesce České akademie zemědělských věd

EDITORIAL BOARD – REDAKČNÍ RADA

Chairman – Předseda

Ing. Vít Prokop, DrSc. (Výzkumný ústav vřivky zvířat, s. r. o., Pohořelice, ČR)

Members – Členové

Prof. Ing. Jozef Bulla, DrSc. (Výzkumný ústav živočišnej výroby, Nitra, SR)

Doc. Ing. Josef Čeřovský, DrSc. (Výzkumný ústav živočišné výroby Praha, pracoviště Kostelec nad Orlicí, ČR)

Prof. Dr. hab. Andrzej Filistowicz (Akademia rolnicza, Wrocław, Polska)

Ing. Ján S. Gavora, DrSc. (Centre for Food and Animal Research, Ottawa, Ontario, Canada)

Dr. Alfons Götschalk (Bayerische Landesanstalt für Tierzucht, Grub, BRD)

Ing. Július Chudý, CSc. (Slovenská poľnohospodárska univerzita, Nitra, SR)

Dr. Ing. Michael Ivan, DSc. (Universiti Pertanian Malaysia, Serdang, Malaysia)

Prof. Ing. MVDr. Pavel Jelínek, DrSc. (Mendelova zemědělská a lesnická univerzita, Brno, ČR)

Prof. Dr. Ing. Ivo Kolář, CSc. (Výzkumný ústav pro chov skotu, s. r. o., Rapotín, ČR)

Ing. Jan Kouřil (Výzkumný ústav rybářský a hydrobiologický Jihočeské univerzity, Vodňany, ČR)

Prof. Ing. František Louda, DrSc. (Česká zemědělská univerzita, Praha, ČR)

Prof. Ing. Josef Mácha, DrSc. (Mendelova zemědělská a lesnická univerzita, Brno, ČR)

RNDr. Milan Margetin, CSc. (VÚŽV Nitra, Stanica chovu a šľachtenia oviec a kôz, Trenčín, SR)

Dr. Paul Millar (BRITBREED, Edinburgh, Scotland, Great Britain)

Ing. Ján Poltársky, DrSc. (Výzkumný ústav živočišnej výroby, Nitra, SR)

Ing. Antonín Stratil, DrSc. (Ústav živočišné fyziologie a genetiky AV ČR, Liběchov, ČR)

Ing. Pavel Trefil, CSc. (Výzkumný ústav živočišné výroby, Praha-Uhřetěves, ČR)

Editor-in-Chief – Vedoucí redaktorka

Ing. Marie Černá, CSc.

Aims and scope: The journal publishes scientific papers and reviews dealing with the study of genetics and breeding, physiology, reproduction, nutrition and feeds, technology, ethology and economics of cattle, pig, sheep, goat, poultry, fish and other farm animal management.

The journal is cited in the bibliographical journal *Current Contents – Agriculture, Biology and Environmental Sciences* and abstracted in *Animal Breeding Abstracts*. Abstracts from the journal are comprised in the databases: *Agris*, *CAB Abstracts*, *Current Contents on Diskette – Agriculture, Biology and Environmental Sciences*, *Czech Agricultural Bibliography*, *Toxline Plus*, *WLAS*.

Periodicity: The journal is published monthly (12 issues per year), Volume 43 appearing in 1998.

Acceptance of manuscripts: Two copies of manuscript should be addressed to: Ing. Marie Černá, CSc., editor-in-chief, Institute of Agricultural and Food Information, Slezská 7, 120 56 Praha 2, Czech Republic, tel.: 02/24 25 34 89, fax: 02/24 25 39 38, e-mail: editor@login.cz.

Subscription information: Subscription orders can be entered only by calendar year (January–December) and should be sent to: Institute of Agricultural and Food Information, Slezská 7, 120 56 Praha 2. Subscription price for 1998 is 177 USD (Europe), 195 USD (overseas).

Cíl a odborná náplň: Časopis publikuje původní vědecké práce a studie typu review z oblasti genetiky, šlechtění, fyziologie, reprodukce, výživy a krmení, technologie, etologie a ekonomiky chovu skotu, prasat, ovcí, koz, drůbeže, ryb a dalších druhů hospodářských zvířat.

Časopis je citován v bibliografickém časopise *Current Contents – Agriculture, Biology and Environmental Sciences* a v časopise *Animal Breeding Abstracts*. Abstrakty z časopisu jsou zahrnuty v těchto databázích: *Agris*, *CAB Abstracts*, *Current Contents on Diskette – Agriculture, Biology and Environmental Sciences*, *Czech Agricultural Bibliography*, *Toxline Plus*, *WLAS*.

Periodicita: Časopis vychází měsíčně (12x ročně), ročník 43 vychází v roce 1998.

Přijímání rukopisů: Rukopisy ve dvou vyhotoveních je třeba zaslat na adresu redakce: Ing. Marie Černá, CSc., vedoucí redaktorka, Ústav zemědělských a potravinářských informací, Slezská 7, 120 56 Praha 2, Česká republika, tel.: 02/24 25 34 89, fax: 02/24 25 39 38, e-mail: editor@login.cz.

Informace o předplatném: Objednávky na předplatné jsou přijímány pouze na celý rok (leden–prosince) a měly by být zaslány na adresu: Ústav zemědělských a potravinářských informací, vydavatelské oddělení, Slezská 7, 120 56 Praha 2. Cena předplatného pro rok 1998 je 744 Kč.

FREKVENCIA GENOTYPOV ŠTYROCH POLYMORFNÝCH SYSTÉMOV MLIEČNYCH BIELKOVÍN U PLEMEN SLOVENSKE STRAKATÉ A PINZGAUSKÉ

GENOTYPIC FREQUENCIES OF FOUR POLYMORPHOUS SYSTEMS OF MILK PROTEINS IN SLOVAKIAN PIED AND PINZGAU BREEDS

E. Chobotová, M. Dobálová, V. Foltys

Research Institute of Animal Production, Nitra, Slovak Republic

ABSTRACT: The goal of the work was to study the polymorphism of milk proteins, and its relation to milk composition in the Slovakian Pied and Slovakian Pinzgau breeds. There were observed 4 polymorphous systems of milk proteins – alpha s_1 -casein, beta-lactoglobulin, beta-casein and kappa-casein. We noticed differences between the breeds in alpha s_1 -casein system, namely in representation of hetero- and homozygous form of alpha s_1 -casein. Higher representation of the homozygous form BB was noticed in the Slovakian Pied breed, the heterozygous form BC prevailed in the Slovakian Pinzgau breed. The most significant differences were with the kappa-casein system. The Slovakian Pied breed shows a higher proportion of the more suitable allele B compared with the Pinzgau breed (in which was apparent the shift to allele A). Milk with the genotypic frequency of AB and BB kappa-casein is more suitable for the cheese industry because it is marked by more suitable time of coagulation and better quality of the rennet coagulum.

polymorphism of milk proteins; Slovakian Pied breed; Slovakian Pinzgau breeds; genotypic frequencies

ABSTRAKT: Cieľom práce bolo sledovanie polymorfizmu mliečnych bielkovín a jeho vzťahu k zloženiu mlieka u plemien slovenské strakaté a slovenské pinzgauské. Sledované boli štyri polymorfne systémy mliečnych bielkovín: alfa s_1 -kazeín, beta-laktoglobulín, beta-kazeín a kapa-kazeín. Rozdiely medzi plemenami sme zaznamenali pri alfa s_1 -kazeínovom systéme, a to v zastúpení hetero- a homozygotnej formy alfa s_1 -kazeínu. Slovenské strakaté plemeno malo vyššie zastúpenie homozygotnej formy BB, u plemena slovenského pinzgauského prevládala heterozygotná forma BC. Štatisticky najvýznamnejšie rozdiely boli pri kapa-kazeínovom systéme. Plemeno slovenské strakaté vykazuje väčší podiel výhodnejšej alely B oproti pinzgauskému plemenu, kde je evidentný posun k alele A. Mlieko s genotypovou frekvenciou kapa-kazeínu AB a BB je vhodnejšie pre syrársky priemysel, pretože sa vyznačuje lepšou dobou zrážania sa, a tým aj kvalitou vzniknutej syreniny.

polymorfizmus mliečnych bielkovín; slovenské strakaté plemeno; slovenské pinzgauské plemeno; genotypové frekvencie

ÚVOD

V súčasnosti sa popri požiadavke na zvýšenie úžitkovosti hospodárskych zvierat dostáva do popredia aj potreba zvyšovania hodnôt kvalitatívnych ukazovateľov mlieka. Nejde tu iba o kvalitu hygienickej povahy, ale hlavne o kvalitatívne zložky, ktoré sú podmienené geneticky. V poslednom období bola venovaná zvýšená pozornosť polymorfizmu mliečnych bielkovín v kravskom mlieku. Bola potvrdená jeho genetická podmienenosť, kvalitatívne aj kvantitatívne pomery medzi jednotlivými frakciami a tiež vzťah polymorfizmu k zloženiu a vlastnostiam mlieka.

Výrobcom a spracovateľom mlieka dnes zaujíma nielen percento bielkovín, ale tiež genetická štruktúra jednotlivých bielkovinových frakcií. Mimoriadny záujem je o genetické štúdium kapa-kazeínu a beta-laktoglobulínu. V mnohých pokusoch sa prejavil vplyv genetic-

kého variantu kapa-kazeínu a beta-laktoglobulínu na syriteľnosť mlieka (Aleandri et al. (1990) a kvalitu vzniknutej syreniny. Tento jav potvrdili aj Havlíček a Dvořák (1997). Plemená hovädzieho dobytká sa vo výskyte jednotlivých alel podstatne líšia, preto je možné uvažovať o vhodnosti ich mlieka pre syrárske spracovanie.

Pri sledovaní vplyvu polymorfizmu bielkovín mlieka na jeho zloženie a zrážacie vlastnosti sa zistilo, že mlieko s variantom kapa-kazeínu BB malo lepší čas zrážania. Vyššia syrárska výťažnosť bola pri beta-kazeíne AA, kapa-kazeíne BB a beta-laktoglobulíne BB (Marziali, Ng-Kwai-Hang, 1986). V rámci bielkovín je v mlieku rozhodujúci obsah kazeínu. Jeho obsah tvorí približne 75–79 % celkového dusíka v mlieku. V kazeínovom komplexe, ktorý sa skladá zo štyroch hlavných frakcií – alfa s_1 , alfa s_2 , beta a kapa, je v najväčšom množstve zastúpená frakcia alfa s. Pre sta-

bilitu kazeinových micel má najväčší význam frakcia kapa, ktorá sa pôsobením iónov vápnika nezráža (H u b a a kol., 1997). Havlíček (1996) konštatuje, že doposiaľ boli popísané tieto genetické varianty kapa-kazeínu: A, B, C, E, F a G. Jednotlivé varianty predstavujú rôzne formy génu, ktoré sa dajú rozlíšiť reštrikčnými enzýmami (Chrenek, 1997). Stanovením genotypu kapa-kazeínu pri plemenách chovaných na Slovensku sa zaoberali viacerí autori. Vašíček et al. (1995) zistili najvyššiu frekvenciu alely B pri slovenskom strakatom plemene. Foltys et al. (1997) uvádzajú zvýšený podiel heterozygotnej formy AB pri kapa-kazeíne u plemena slovenské strakaté. Naproti tomu pinzgauský dobytok má nižšie zastúpenie alely B a je tu evidentný posun k alele A.

V súčasnosti sa najväčší dôraz kladie na sledovanie vzťahov medzi genetickými variantami mliečnych bielkovín a kvalitatívnymi vlastnosťami mlieka. Tukové a proteínové koncentrácie sú vyššie pre mlieko s genotypom alfa s₁-kazeínu BC, beta-kazeínu AB a kapa-kazeínu BB. Pre výrobu syrov sa odporúča selekcia kráv na genotypy kapa-kazeínu BB a beta laktoglobulínu BB (Ng-Kwai-Hang et al., 1986). Ďalej sa uvádza, že vyššia výťažnosť mlieka pri výrobe syrov bola pri beta-kazeíne AA, beta-laktoglobulíne BB a kapa-kazeíne BB (Marzali, Ng-Kwai-Hang, 1986).

MATERIÁL A METÓDA

Vlastné sledovanie bolo robené na 84 dojniciach, z toho bolo 34 dojníc plemena slovenské strakaté a 50 dojníc plemena slovenské pinzgaušké. Dojnice boli na druhej a vyšších laktáciách. Počas jedného roka boli mesačne odoberané vzorky od jednotlivých dojníc a analyzované na uvedené vlastnosti. Časť vzoriek bola zmrazená a následne bola prevedená elektroforetická fenotypizácia. Použitá bola horizontálna elektroforéza na škrobom gely, s prídavkom močovinou a merkaptanolu. Vzorky boli odtučené odstredením a nanášané pomocou filtračných papierikov do štartovacieho rezu

v geli. Vlastná separácia trvala 4 až 6 hodín. Vzorky boli farbené v roztoku Comassie blue a po odfarbení odpočítané podľa známej schémy (Larsen a Thymann). V rámci možnosti použitej elektroforetickej separácie boli sledované štyri polymorfne systémy mliečnych bielkovín: alfa s₁-kazeín, beta-laktoglobulín, beta-kazeín a kapa-kazeín. Na infračervenom analyzátori Multispec bol stanovený obsah bielkovín (% – g/100 g). Obsah čistých bielkovín (g/100 g) bol stanovený metódou podľa Liebermana v zrazenine čistých bielkovín, za použitia Almenovho roztoku, po odfiltrovaní nebielkovinových dusíkatých látok. Metódou podľa Pfeiffera bol určený obsah kazeínu (g/100 g). Fotokolorimetricky, po farbiacej reakcii s p-dimetylaminobenzaldehydom (Erichovo činidlo) a pri 420 nm bola určená vo vzorkách mlieka koncentrácia močoviny (mmol/l). Titračná kyslosť bola stanovená podľa Soxhlet-Henkela (°SH 2,5 mmol/l). Na prístroji Fossomatic 90 bol stanovený fluorooptoelektronicky počet somatických buniek v mlieku (1 000/ml). Zastúpenie jednotlivých genotypových frekvencií v rámci spomenutých polymorfnych systémov a kvalitatívnych ukazovateľov mlieka sme hodnotili periodicky. Výsledky boli vyhodnotené základnými štatisticko-matematickými metódami a rozdiely medzi skupinami boli otestované F-testom pri použití programu Statgraphics.

VÝSLEDKY A DISKUSIA

Genotypové frekvencie zachytené pri sledovaných plemenách sú v absolútnych i relatívnych hodnotách zaznamenané v tab. I. Ako vyplýva z tabuľky, v genotypovej frekvencii alfa s₁-kazeínového systému sú u sledovaných plemien rozdiely. Plemeno slovenské strakaté malo vyššie zastúpenie homozygotnej formy BB – 60 % oproti plemenu pinzgavskému, kde prevládala heterozygotná forma BC – 88 %. Tieto výsledky potvrdila aj práca autorov Foltys et al. (1997), v ktorej boli vyššie percentuálne zastúpenie homozygotnej formy BB u slovenského strakatého plemena

I. Absolútna a relatívna početnosť polymorfnych systémov k diskretným premenným – Absolute and relative frequencies of polymorphous systems for discrete variables

Plemena ¹	Alfa-kazeín ²		Beta-laktoglobulín ³			Beta-Cn			Kapa-Cn ⁴			Celkom ⁵
	BB	BC	AA	AB	BB	AA	AB	AC	AA	AB	BB	
S	20	14	3	30	1	2	26	6	4	20	10	34
P	6	44	2	48	–	8	5	37	29	14	7	50
Celkom	26	58	5	78	1	10	31	43	33	34	17	84
Plemena	alfa-kazeín		beta-laktoglobulín			beta-Cn			kapa-Cn			celkom
	BB	BC	AA	AB	BB	AA	AB	AC	AA	AB	BB	
S	59	41	9	88	3	6	76	18	12	59	29	40
P	12	88	4	96	–	16	10	74	58	28	14	60
Celkom	31	69	6	93	1	12	37	51	39	40	21	100

S = slovenské strakaté – Slovakian Pied; P = slovenské pinzgaušké – Slovakian Pinzgau

¹breeds, ²alpha-casein, ³beta-lactoglobulin, ⁴kappa-Cn, ⁵total

Ia. Charakteristiky rozloženia premenných pre jednotlivé genotypy – Characteristics of distribution of variables for the particular genotypes

Systém ¹	Genotyp ²	Bielkoviny ³ (g/100 g)					Čisté bielkoviny ⁴ (g/100 g)				
		n	\bar{x}	$s_{\bar{x}}$	min.	max.	n	\bar{x}	$s_{\bar{x}}$	min.	max.
Alfa-kazeín ⁵	BB	26	3,19	0,12	2,96	3,47	26	2,79	0,27	2,26	3,30
	BC	58	3,21	0,14	2,85	3,50	58	2,72	0,31	1,55	3,30
Beta-laktoglobulín ⁶	AA	5	3,10	0,12	2,85	3,32	5	2,76	0,30	1,55	3,30
	AB	78	3,27	0,11	3,07	3,50	78	2,74	0,34	1,67	3,12
	BB	1	3,20	0,10	3,00	3,38	1	2,77	0,27	2,30	3,30
Beta-kazeín ⁷	AA	10	3,19	0,14	2,96	3,50	10	2,72	0,32	1,67	3,30
	AB	31	3,19	0,15	2,85	3,47	31	2,78	0,32	1,55	3,12
	AC	43	3,20	0,10	3,00	3,38	43	2,77	0,27	2,30	3,10
Kapa-kazeín ⁸	AA	33	3,24	0,13	2,96	3,50	33	2,80	0,20	2,44	3,30
	AB	34	3,21	0,16	2,85	3,47	34	2,78	0,29	2,28	3,10
	BB	17	3,21	0,13	2,98	3,48	17	2,73	0,38	1,55	3,30

¹system, ²genotype, ³proteins, ⁴net proteins, ⁵alpha-casein, ⁶beta-lactoglobulin, ⁷beta-casein, ⁸kappa-casein

Ib. Charakteristiky rozloženia premenných pre jednotlivé genotypy – Characteristics of distribution of variables for the particular genotypes

Systém ¹	Genotyp ²	Kazeín ³ (g/100 g)					Močovina ⁴ (mmol/l)				
		n	\bar{x}	$s_{\bar{x}}$	min.	max.	n	\bar{x}	$s_{\bar{x}}$	min.	max.
Alfa-kazeín ⁵	BB	26	2,25	0,27	1,31	2,57	26	5,34	1,64	2,53	9,53
	BC	58	2,26	0,31	1,31	2,99	58	4,52	1,42	1,26	7,67
Beta-laktoglobulín ⁶	AA	5	2,23	0,21	1,96	2,73	5	4,60	1,85	2,00	9,53
	AB	78	2,12	0,30	1,34	2,57	78	5,15	1,04	3,33	7,30
	BB	1	2,25	0,27	1,31	2,56	1	4,81	1,74	1,26	8,82
Beta-kazeín ⁷	AA	10	2,26	0,24	1,74	2,73	10	4,98	1,79	2,86	9,53
	AB	31	2,19	0,32	1,34	2,72	31	4,77	1,19	2,00	7,30
	AC	43	2,25	0,27	1,31	2,56	43	4,62	1,72	1,26	8,82
Kapa-kazeín ⁸	AA	33	2,24	0,29	1,31	2,73	33	4,71	1,45	2,00	8,82
	AB	34	2,28	0,21	1,78	2,65	34	4,67	1,09	2,86	7,30
	BB	17	2,17	0,31	1,34	2,72	17	5,05	2,10	1,26	9,53

¹system, ²genotype, ³casein, ⁴urea, ⁵alpha-casein, ⁶beta-lactoglobulin, ⁷beta-casein, ⁸kappa-casein

Ic. Charakteristiky rozloženia premenných pre jednotlivé genotypy – Characteristics of distribution of variables for the particular genotypes

Systém ¹	Genotyp ²	Kyslosť ³ (°SH)					PSB (1 000/ml)				
		n	\bar{x}	$s_{\bar{x}}$	min.	max.	n	\bar{x}	$s_{\bar{x}}$	min.	max.
Alfa-kazeín ⁴	BB	26	6,58	0,30	6,10	7,60	26	156,51	51,04	69	293
	BC	58	6,40	0,29	5,60	6,80	58	150,30	43,35	89	320
Beta-laktoglobulín ⁵	AA	5	6,49	0,25	5,90	6,90	5	155,63	45,57	97	320
	AB	78	6,44	0,40	5,60	7,30	78	153,87	38,45	89	264
	BB	1	6,52	0,27	6,10	7,60	1	146,70	52,78	69	293
Beta-kazeín ⁶	AA	10	6,36	0,32	5,60	6,90	10	150,67	44,16	89	320
	AB	31	6,57	0,31	5,90	7,30	31	158,83	39,64	110	264
	AC	43	6,53	0,27	6,10	7,60	43	145,70	52,61	69	293
Kapa-kazeín ⁷	AA	33	6,35	0,27	5,60	6,70	33	156,57	51,79	89	320
	AB	34	6,48	0,19	6,10	6,80	34	157,50	57,93	69	294
	BB	17	6,45	0,34	5,90	7,30	17	151,80	36,31	97	264

¹system, ²genotype, ³acidity, ⁴alpha-casein, ⁵beta-lactoglobulin, ⁶beta-casein, ⁷kappa-casein

Závislá premenná ¹	Triediaca premenná ²										
	alfa kazeín ³		beta-laktoglobulín ⁴			beta-kazeín			kapa-kazeín		
	BB : BC	AA : AB	AA : BB	AB : BB	AA : AB	AA : AC	AB : AC	AA : AB	AA : BB	AB : BB	
Bielkoviny ⁵	-	+++	++	+	-	-	-	-	-	+	
Čisté bielkoviny ⁶	-	-	-	-	-	-	-	-	-	+	
Kazeín ⁷	-	++	-	-	-	-	-	-	-	+	
Močovina ⁸	++	-	-	-	-	-	-	-	-	-	
Kyslosť ⁹	++	-	-	-	+	+	-	+	+	+	
PSB	-	-	-	-	-	-	-	-	-	-	

+ $P < 0,05$; ++ $P < 0,01$; +++ $P < 0,001$

¹dependent variable, ²classification variable, ³alpha-casein, ⁴beta-lactoglobulin, ⁵proteins, ⁶net proteins, ⁷casein, ⁸urea, ⁹acidity

a vyššie percentuálne zastúpenie heterozygotnej formy BC u slovenského pinzgauškého plemena. K podobným výsledkom dospeli pri štúdiu genetického polymorfizmu bielkovín mlieka slovenského strakatého plemena i Žitný et al. (1995), ktorí zistili, že v rámci systému alfa s₁-kazeínu bolo percentuálne zastúpenie homozygotnej formy BB 95,3 % a heterozygotnej formy BC 4,7 %.

Genotypové frekvencie beta-laktoglobulínu sú najčastejšie zastúpené heterozygotnou formou AB. V našom prípade sa ich frekvencia v rámci jednotlivých plemien pohybovala od 88 do 96 %. Majoritné zastúpenie heterozygotnej formy AB zistili H a n u š (1995) u českého strakatého dobytká 32 % AA, 41 % AB, 27 % BB a Žitný et al. (1995) u slovenského strakatého dobytká 23,8 % AA, 57,1 % AB, 19,1 % BB.

Pokiaľ ide o frekvenciu beta-kazeínu, najčastejšie sa vyskytovala heterozygotná forma AB u slovenského strakatého plemena a forma AC u pinzgauškého plemena.

Genotypové frekvencie v rámci kapa-kazeínového systému vykazovali značné rozdiely medzi sledovanými plemenami. Plemeno slovenské strakaté malo najfrekventovanejšiu heterozygotnú formu AB – 59 % a homozygotnú formu BB – 29 %. Slovenské pinzgaušké plemeno malo nízke zastúpenie týchto dvoch foriem a vyššie zastúpenie homozygotnej formy AA – 58 %. Na nadpriemerné zastúpenie alely B (až 53,4 %) poukazujú H u b a et al. (1997) u plemena braunvieh. Vyššiu hodnotu zaznamenali V a š i č e k et al. (1995) pri slovenskom strakatom plemene (56 %).

V tab. IIa, b, c sú uvedené základné štatistické charakteristiky sledovaných premenných (bielkoviny, čisté bielkoviny, kazeín, močovina, titračná kyslosť, PSB) vzhľadom ku genotypom jednotlivých systémov. Vo vzťahu polymorfizmu mliečnych bielkovín k zložkám mlieka sa ako najvýznamnejšie ukazujú systémy beta-laktoglobulínu a kapa-kazeínu. Vplyv beta-laktoglobulínu sa prejavil významne v obsahu bielkovín (AA < AB > BB) a v obsahu kazeínu (AA > AB < BB) (tab. II). H a n u š (1995) zistil vplyv beta-laktoglobulínu na obsah srvátkových bielkovín (AA > AB > BB), obsah kazeínu (AA < AB < BB) a titračnú kyslosť ka-

zeínu (AA < AB < BB). Vzhľadom na to, že systém beta-laktoglobulínu je heterogénny, môžeme uvažovať o ovplyvnení génových frekvencií požadovaným smerom, pričom ako výhodnejšie sa ukazuje zvýšenie frekvencie alely B beta-laktoglobulínu. Vplyv kapa-kazeínu sa prejavil v obsahu bielkovín (AA < AB < BB), čistých bielkovín (AA < AB < BB), kazeínu (AA < AB < BB) a titračnej kyslosti.

H a n u š (1995) zistil významný vplyv kapa-kazeínu na aktívnu kyslosť (AB > AB > BB), titračnú kyslosť, obsah močoviny a PSB. V heterogénnom systéme kapa-kazeínu je zreteľná väzba alely B na zlepšenie syrářských vlastností mlieka.

LITERATÚRA

- ALEANDRI, R. – BUTTAZZONI, L. G. – SCHNEIDER, J. C. – CAROLI, A. – DAVOLI, R.: The effects of milk protein polymorphism on milk components and cheese-producing ability. *J. Dairy Sci.*, 73, 1990: 241–255.
- BOVENHUIS, H. – VAN ARENDONK, J. A. M.: Estimation of milk protein gene frequencies in crossbred cattle by maximum likelihood method. *J. Dairy Sci.*, 74, 1991.
- FOLTYS, V. – CHOBOTOVÁ, E. – DOBÁLOVÁ, M.: Monitoring genetického zloženia pre kapa-kazeín a beta-laktoglobulín v populácii dojnic v SR. [Čiastková správa za subetapu.] Nitra, VÚŽV 1997. 8 s.
- HANUŠ, O.: Složení a vlastnosti mléka, využitelné v plemennářské práci a prvovýrobě. [Autoreferát dizertačnej práce.] Rapotín, 1995. 34 s. – Výskumný ústav pro chov skotu.
- HAVLÍČEK, Z.: Genetická variabilita mliečnych proteínů ve vztahu k jejich produkci a kvalitě. [Autoreferát doktorantskej dizertačnej práce.] Brno, 1996. 28 s. – Mendelova zemědělská a lesnická univerzita.
- HAVLÍČEK, Z. – DVOŘÁK, J.: Genotypes of milk proteins and technological properties of milk. In: Book of Abstracts of the 48th Annual Meeting of the EAAP, Vienna, August 25–28, 1997: 50.
- HUBA, J. et al.: Genotypizácia hnedého dobytká (braunvieh) chovaného na Slovensku. [Správa za účelovú činnosť.] Nitra, VÚŽV 1997.

- CHRENEK, P.: Využitie PCR-RFLP analýz na detekciu genetických variantov mliečnych bielkovín. [Doktorantská dizertačná práca.] SPU Nitra, 1997. 135 s. – Slovenská poľnohospodárska univerzita.
- CHRENEK, P. – ŽITNÝ, J. – HALADOVÁ, D. – VAŠÍČEK, D. – BAUEROVÁ, M. – MICHALIČKOVÁ, E. – MICHALCOVÁ, A. – KÚBEK, A. – BULLA, J.: Stanovenie kapa-kazeínového a beta-laktoglobulínového genotypu dojnic analýzou DNA a bielkovín. Vedec. Práce VÚŽV Nitra, XXIX, 1996. 10 s.
- MARZIALI, A. S. – NG-KWAI-HANG, K. F.: Effects of milk composition and genetic polymorphism on coagulation properties of milk. J. Dairy Sci., 69, 1986: 1793–1798.
- NG-KWAI-HANG, K. F. – HAYES, J. F. – MOXLEY, J. E. – MONARDES, H. G.: Relationships between milk protein polymorphisms and major milk constituents in Holstein-Friesian cows. J. Dairy Sci., 69, 1986: 22–26.
- VAŠÍČEK, D. – UHRÍN, P. – CHRENEK, P. – BAUEROVÁ, M. – OBERFRANC, M. – BULLA, J.: Genotyping of kapa-casein in different cattle breeds in Slovakia. Živoč. Vyr., 40, 1995: 241–244.
- ŽITNÝ, J. – TRAKOVICKÁ, A. – MICHALIČKOVÁ, E. – KÚBEK, A. – HEDERA, M.: Polymorfizmus bielkovín mlieka a výskyt mastitíd kráv slovenského strakatého plemena. Acta zootechn. Univ. agric. (Nitra), 1995: 79–86.

Došlo 9. 2. 1998

Prijaté k publikovaniu 14. 7. 1998

Kontaktná adresa:

MVDr. Eva Chobotová, Výskumný ústav živočíšnej výroby, Hlohovská 2, 949 92 Nitra, Slovenská republika, tel.: 087/54 61 66, fax: 087/54 63 61

**Nejčerstvější informace o časopiseckých článcích
poskytuje automatizovaný systém**

Current Contents

na disketách

Ústřední zemědělská a lesnická knihovna odebírá časopis „**Current Contents**“ řadu „**Agriculture, Biology and Environmental Sciences**“ a řadu „**Life Sciences**“ na disketách. Řada „**Agriculture, Biology and Environmental Sciences**“ je od roku 1994 k dispozici i s abstrakty. Obě tyto řady vycházejí 52krát ročně a zahrnují všechny významné časopisy a pokračovací sborníky z uvedených oborů.

Uložení informací z **Current Contents** na disketách umožňuje nejrozmanitější referenční služby z prakticky nejčerstvějších literárních pramenů, neboť báze dat je **doplňována každý týden** a neprodleně expedována odběratelům. V systému si lze nejen prohlížet jednotlivá čísla **Current Contents**, ale po přesném nadefinování sledovaného profilu je možné adresně vyhledávat informace, tisknout je nebo kopírovat na disketu s možností dalšího zpracování na vlastním počítači. Systém umožňuje i tisk žádanek o separát apod. Kumulované vyhledávání v šesti číslech **Current Contents** najednou velice urychluje rešeršní práci.

Přístup k informacím Current Contents je umožněn dvojím způsobem:

- 1) Zakázkový přístup** – po vyplnění příslušného zakázkového listu (objednávky) je vhodný především pro mimopražské zájemce.

Finanční podmínky: – použití PC – 15 Kč za každou započatou půlhodinu
– odborná obsluha – 10 Kč za 10 minut práce
– vytištění rešerše – 1 Kč za 1 stranu A4
– žádanky o separát – 1 Kč za 1 kus
– poštovné + režijní poplatek 15 %

- 2) „Self-service“** – samoobslužná práce na osobním počítači v ÚZLK.

Finanční podmínky jsou obdobné. Vzhledem k tomu, že si uživatel zpracovává rešerši sám, je to maximálně úsporné. (Do kalkulace cen nezapočítáváme cenu programu a databáze **Current Contents**.)

V případě Vašeho zájmu o tyto služby se obraťte na adresu:

Ústřední zemědělská a lesnická knihovna

Dr. Bartošová

Slezská 7

120 56 Praha 2

Tel.: 02/24 25 79 39, l. 520, fax: 02/24 25 39 38

Na této adrese obdržíte bližší informace a získáte formuláře pro objednávku zakázkové služby. V případě „self-servisu“ je vhodné se předem telefonicky objednat. V případě zájmu je možné si objednat i průběžné sledování profilu (cena se podle složitosti zadání pohybuje čtvrtletně kolem 100 až 150 Kč).

VPLYV LÚHOVANÝCH ZRNÍN NA BACHOROVÚ FERMENTÁCIU

THE EFFECT OF CHEMICALLY TREATED GRAINS ON RUMINAL FERMENTATION

M. Demeterová, V. Vajda

University of Veterinary Medicine, Košice, Slovak Republic

ABSTRACT: Trials were conducted to study changes in the chemical composition of grains treated with sodium hydroxide (3% and 5% NaOH for wheat and barley, resp.) and the effect of their feeding on some parameters of ruminal fermentation (pH, NH₃, acetic, propionic, butyric and lactic acid) and on nutrient digestibility *in situ* in cattle. Wheat and barley grain treatment with sodium hydroxide increased water and ash contents and decreased contents of fat, fiber and nitrogen-free extract in both grains. In trial 1, heifers received daily rations consisting of hay (5–6 kg) and concentrate mixture supplement (1 kg), which contained 20% of NaOH treated barley and 39% of NaOH treated wheat. Taking into account the time dependence since feeding, the level of ruminal fermentation – pH, total and individual volatile fatty acids, did not show any significant changes after feeding NaOH treated grains at a low concentration of nutrients (13% dry matter met by concentrate) to heifers. Trial 2 included 24 dairy cows divided into three groups. Silage, hay and concentrate mixture supplement (4.5 kg) were the basic ingredients of daily ration for the first group. The second group received daily ration identical with that for the first group, but a part of concentrate mixture was replaced by NaOH treated wheat (45%). Daily ration for the third group consisted of green forage, silage, hay and a part of concentrate mixture was replaced by NaOH treated wheat (45%) similarly like in the second group. Following the above replacement of concentrate mixture by NaOH treated wheat and a high level of nutrition (25% of dry matter met by concentrate) in winter ration (2nd group) and in transition ration (3rd group), dairy cows tended to show a decrease in total volatile fatty acids, acetic and propionic acids, a significant decrease in butyric acid ($P < 0.01$) and a significant increase in lactic acid ($P < 0.01$ and $P < 0.001$, resp.) in relation to full replacement of concentrate by concentrate mixture. Heifers with fistulas fed hay were used in trial 3. Nylon bags were taken out from the rumen in 3, 6, 9 and 24 hours. The values of dry matter digestibility and digestibility of all nutrients in ground wheat are significantly higher at all time intervals if compared with the values for NaOH treated whole wheat grains, which together with the results of ruminal fermentation confirms a shift of nutrient and starch digestion from ruminal fermentation to enzymatic digestion. Incubation in whole grains was also a reason for lower nutrient digestibility *in situ* in NaOH treated wheat. No health disorders of animals were observed after long-time feeding of NaOH treated grain supplement.

NaOH treated grains; ruminal fermentation; digestibility; cattle

ABSTRAKT: V práci boli sledované zmeny chemického zloženia zrnín po lúhovaní a vplyv ich skrmovania na niektoré ukazovatele bachorovej fermentácie a stráviteľnosť živín *in situ* u hovädzieho dobytku. V časovej závislosti po nakŕmení úroveň ruminálnej fermentácie – pH, celkové, ako aj jednotlivé UMK pri skrmovaní lúhovaného jadrového krmíva pri nízkej koncentrácii živín (13 % sušiny uhradenej jadrovým krmivom) nevykazovali významné zmeny. Pri 45% úhrade jadrovej zmesi lúhovanou pšenice pri vysokej úrovni výživy (25 % sušiny uhradenej jadrovým krmivom) tak v zimnej, ako aj prechodnej kŕmnej dávke (jar) bol zistený pokles celkových UMK, kyseliny octovej a kyseliny propiónovej, významný pokles kyseliny maslovej ($P < 0,01$) a významný vzostup kyseliny mliečnej ($P < 0,01$, resp. $P < 0,001$) v porovnaní s plnou úhradou jadrového krmíva jadrovou zmesou. Hodnoty stráviteľnosti sušiny a všetkých živín zrna pšenice pri úprave šrotovaním sú v porovnaní so stráviteľnosťou lúhovaného celého zrna významne vyššie vo všetkých časových intervaloch (číselné údaje stráviteľnosti po 6 hodinách, čo zodpovedá času evakuácie jadrového krmíva z bachora do abomasu, boli u šrotovanej pšenice v porovnaní s lúhovaným zrnom pri sušine 66,5 %, resp. 31,5 %, $P < 0,001$, pri NL 45,9 %, resp. 37,0 %, $P < 0,001$, pri tuku 62,6 %, resp. 44,0 %, $P < 0,001$, pri BNLV 72,7 %, resp. 39,5 %, $P < 0,001$), čo spolu s výsledkami ruminálnej fermentácie potvrdzuje posun trávenia živín a škrobu z oblasti ruminálnej fermentácie do enzymatického trávenia. Dôvodom nižšej stráviteľnosti živín *in situ* u lúhovanej pšenice bola aj jej inkubácia v celých zrnách. Pri dlhodobom skrmovaní prídavku lúhovaných zrnín neboli pozorované poruchy zdravotného stavu zvierat.

lúhované zrniny; ruminálna fermentácia; stráviteľnosť; hovädzí dobytok

Skrmovanie celých zŕn v kŕmnych dávkach pre veľké prežúvavce má za následok ich nízke využitie a zvýšenú exkréciu trusom. Úprava zŕnín je vo všeobecnosti spájaná so zlepšením účinnosti využitia živín ako bacherovými mikroorganizmami, tak aj v celom zažívacom trakte. Metódy fyzikálnej úpravy zŕnín (šrotovanie, granulovanie a i.) – mnohé zahŕňujú aj vplyv zvýšenej teploty a vlhkosti, urýchľujú zmenu štruktúry škrobových zŕn amylolytické trávenie ako pôsobením mikroorganizmov, tak aj účinkom pankreatických enzýmov (Nocek, Tamminga, 1991). Zaradenie vysokých dávok šrotovaných obilnín do diét môže viesť k poruchám zažívacieho aparátu (ruminitídy), zníženej stráviteľnosti vlákniny objemových kŕmív a tiež k poklesu obsahu tuku v mlieku (McRae, Armstrong, 1969; Chimowano et al., 1976; Orskov, Greenhalgh, 1977; Veselý, 1994).

Pri použití rôznych spôsobov chemickej úpravy zŕnín bola pozorovaná zrýchlená alebo spomalená ruminálna degradácia, v závislosti od použitej chemickej látky a jej koncentrácie.

Chemické ošetrenie použitím lúhu sodného vedie k narušeniu povrchových obalov zrna parciálnou hydrolyzou hemicelulózy a lignínu (Berger et al., 1979) a spôsobí nabobtnanie vonkajších škrobových granúl, takže škrobový endosperm je postupne dostupný pre bacherové mikroorganizmy a enzýmy. V porovnaní so šrotovaným zŕnom sú lúhom ošetrené obilniny trávené pomalšie, udržiavajú vyššie pH bachora a vedú k vyššiemu príjmu objemových kŕmív (Orskov et al., 1978).

Cieľom tejto práce bolo zistiť zmeny chemického zloženia zŕnín po lúhovaní, vplyv skrmovania lúhovaných obilnín na niektoré ukazovatele bacherovej fermentácie a stráviteľnosť živín *in situ*.

MATERIÁL A METÓDA

Pokusy boli vykonané na dospelom hovädzom dobytku (jalovica, dojnica). Zvieratám boli ku základnej kŕmnej dávke pridávané obilniny ošetrené lúhom sodným. Pri úprave pšenice lúhom sodným boli na 100 kg pšenice aplikované 3 kg NaOH, ktoré boli rozpustené v 20 l vody. Pri úprave jačmeňa bolo použitých 5 kg NaOH. Takto upravené zrniny boli pred skrmovaním štyri dni voľne uložené.

V bachorovom obsahu boli stanovené: pH potenciomricky, NH₃ titračne a UMK (octová, propiónová, maslová, mliečna) izotachoforeticky.

Obsah živín v kŕmivách vo všetkých pokusoch bol stanovený priamo analytickými metódami podľa STN 46 7092.

Experiment 1

V tomto experimente bol zisťovaný vplyv jadrovej zmesi s prídavkom lúhovaných zŕnín (59 %) na bacherovú fermentáciu u jalovíc pri nízkej koncentrácii živín v kŕmnej dávke. Šiestim jaloviciam (ž.h. 380 kg) bola v experimentálnych podmienkach po dobu troch týždňov podávaná kŕmna dávka pozostávajúca zo sena (5–6 kg) a prídavku jadrovej zmesi v množstve 1 kg na kus a deň, ktorá obsahovala 20 % lúhovaného jačmeňa a 39 % lúhovanej pšenice. Zvieratá prijali v tejto kŕmnej dávke 6,3 kg sušiny, 34,61 MJ NEL a 431,15 g PDI. Zloženie a obsah živín v kŕmnej zmesi sú uvedené v tab. I.

Bacherový obsah bol odoberaný pred nakŕmením a ďalej 1, 2,5 a 4 hodiny po nakŕmení.

Experiment 2

Vplyv lúhovanej pšenice (45 % celkovej dávky jadrového kŕmiva) na ruminálny metabolizmus dojníc pri vysokej koncentrácii živín v kŕmnej dávke bol zisťovaný u 24 náhodne vybraných dojníc medzi 80. a 100. dňom laktácie, ktoré boli rozdelené do troch skupín. Základom kŕmnej dávky v prvej skupine bola siláž a seno, ku ktorým bola pridávaná jadrová zmes (tab. II). Druhá skupina dostávala kŕmnu dávku zhodnú s prvou skupinou s tým rozdielom, že časť jadrovej zmesi (45 %) bola nahradená lúhovanou pšenicou. V tretej skupine pozostávala kŕmna dávka zo zeleného kŕmiva, doplneného silážou a senom a časť jadrovej zmesi (45 %) bola nahradená lúhovanou pšenicou (prechod na jarnú kŕmnu dávku). Zloženie kŕmnych dávok a obsah prijatých živín a energie sú uvedené v tab. II, obsah živín v použitých kŕmivách v tab. III.

I. Zloženie a obsah živín v jadrovej zmesi skrmovanej jaloviciam pri nízkej koncentrácii živín v kŕmnej dávke (experiment 1) – Composition and nutrient content in concentrate mixture fed to heifers at a low concentration of nutrients in daily ration (trial 1)

Komponent ¹	%
Jačmeň lúhovaný ²	20
Ovos ³	20
Hrach ⁴	20
Pšenica lúhovaná ⁵	39
Kŕmna močovina ⁶	1
Obsah živín ⁷	%
Sušina ⁸	83,25
Popol ⁹	4,25
Hrubý proteín ¹⁰	13,58
Hrubý tuk ¹¹	1,56
Hrubá vláknina ¹²	5,20
BNLV ¹³	58,66
ŠH ¹⁴	66,56
NEL (MJ/kg)	6,47
PDI (g/kg)	80,92

¹ingredient, ²NaOH treated barley, ³oats, ⁴peas, ⁵NaOH treated wheat, ⁶feeding urea, ⁷nutrient content, ⁸dry matter, ⁹ash, ¹⁰crude protein, ¹¹crude fat, ¹²crude fiber, ¹³nitrogen-free extract, ¹⁴starch value

II. Zloženie kŕmnych dávok, obsah prijatých živín a energie v jednotlivých skupinách dojníc kŕmených kŕmnom dávkou s vysokou koncentráciou živín (experiment 2) – Formulation of daily rations, content of ingested nutrients and energy in the individual groups of dairy cows fed daily rations with a high concentration of nutrients (trial 2)

Krmivo ¹ (kg)	1	2	3
Kukuricičná siláž ²	15,00	15,00	5,00
Siláž ďatelinostrávná ³	10,00	10,00	5,00
Seno lúčne ⁴	3,00	3,00	3,00
Zelené krmivo ⁵	–	–	20,00
Pastva ⁶	–	–	7,50
Jadrová zmes ^{7*}	4,50	2,50	2,50
Pšenica lúhovaná ⁸	–	2,00	2,00
Minerálna zmes ⁹ (g)	94	94	94
Sušina ¹⁰ (kg)	14,29	14,30	14,14
NEL (MJ)	81,50	83,80	85,7
PDI (g)	1 053	1 046	1 119,1
Vláknina ¹¹ (% v S)	24,1	23,9	20,9

* Zloženie jadrovej zmesi: hrach 20 %, jačmeň 30 %, ovos 20 %, pšenica 30 %

¹ – kontrola, 2, 3 – kŕmna dávka so zaradením lúhovanej pšenice

* Concentrate mixture composition: peas 20%, barley 30%, oats 20%, wheat 30%

¹ – control, 2, 3 – daily ration containing NaOH treated wheat

¹ feed, ² corn silage, ³ clover-grass silage, ⁴ meadow hay, ⁵ green forage, ⁶ pasture, ⁷ concentrate mixture, ⁸ NaOH treated wheat, ⁹ mineral mixture, ¹⁰ dry matter, ¹¹ fiber

Zvieratám bol odoberaný bachorový obsah 4 až 5 hodín po nakŕmení.

Experiment 3

Vplyv fyzikálnej (šrotovanie) a chemickej (lúhovanie) úpravy pšenice na stráviteľnosť živín v bachore sáčkovou metódou bol zisťovaný v bachorovom prostredí fistulovaných jalovíc. Kŕmna dávka pozostávala zo sena. Sáčky so vzorkami pšeničného šrotu (kontrola) a lúhovanej pšenice (celé zrno) boli z bachora vyberané po 3, 6, 9 a 24 hodinách. Vo zbytku bol zisťovaný obsah sušiny, dusíkatých látok, tuku, vlákniny a BNLV a boli vypočítané koeficienty stráviteľnosti. Výsledky boli zhodnotené štatisticky.

VÝSLEDKY A DISKUSIA

Zmeny chemického zloženia zŕnín pri lúhovaní (obsah živín v neošetrených a lúhovaných zŕnínach) sú uvedené v tab. IV.

U lúhovaných zŕnín bol zistený zvýšený obsah vlhkosti, čo je dôsledok prídavku vody počas ošetrenia zrna a zvýšený obsah popola prídanim lúhu v 3% a 5% koncentrácii u pšenice, resp. jačmeňa. Znížený obsah tuku a vlákniny v lúhovaných kŕmivách je možné vysvetliť rozpustnosťou tukov a tuku podobných látok, resp. štiepením vlákniny pôsobením lúhu sodného

III. Obsah živín v kŕmivách (%) pre dojnice v kŕmnych dávkach s vysokou koncentráciou živín (experiment 2) – Nutrient contents in feeds (%) for dairy cows, feed rations with a high concentration of nutrients (trial 2)

Krmivo ¹	Sušina ⁹	Popol ¹⁰	Hrubý proteín ¹¹	Hrubý tuk ¹²	Hrubá vláknina ¹³	BNLV ¹⁴
Siláž kukuričná ²	31,83	1,83	3,12	2,20	7,49	18,46
Siláž ďatelinostrávná ³	33,33	3,14	4,04	4,50	11,25	10,40
Seno lúčne ⁴	84,11	5,05	5,61	2,18	30,35	40,92
Zelené krmivo ⁵	25,01	2,55	2,88	0,95	7,16	11,47
Pastva ⁶	16,50	1,63	3,14	0,83	3,47	7,43
Jadrová zmes ⁷	78,04	4,36	12,46	1,48	2,44	57,30
Pšenica lúhovaná ⁸	78,43	4,85	8,83	1,09	1,08	62,58

For 1–8 see Tab. II; ⁹ dry matter, ¹⁰ ash, ¹¹ crude protein, ¹² crude fat, ¹³ crude fiber, ¹⁴ nitrogen-free extract

IV. Obsah živín v pšenici (P) a jačmeni (J) (%) – Nutrient contents in wheat (P) and barley (J) (%)

Krmivo ¹	Sušina ⁶ (%)	V sušine ⁷ (%)				
		popol ⁸	HP	HT	HV	BNLV
Pšenica nelúhovaná ²	85,73	1,83	10,23	1,81	3,11	83,02
Pšenica lúhovaná ³	78,43	6,18	11,26	1,39	1,38	79,79
Jačmeň nelúhovaný ⁴	90,46	2,70	10,47	1,82	3,80	81,21
Jačmeň lúhovaný ⁵	82,76	7,91	10,32	0,97	0,81	79,99

HP – hrubý proteín, HT – hrubý tuk, HV – hrubá vláknina, BNLV – bezdusíkaté látky výťažkové

HP – crude protein, HT – crude fat, HV – crude fiber, BNLV – nitrogen-free extract

¹ feed, ² untreated wheat, ³ NaOH treated wheat, ⁴ untreated barley, ⁵ NaOH treated barley, ⁶ dry matter ⁷ in dry matter, ⁸ ash

a zvýšenej teploty počas ošetrovania zrnín. Mierny pokles hodnôt BNLV u lúhom ošetrovaných zrnín je možné pripísať rozpustnosti niektorých sacharidových zložiek vo vode.

Experiment 1

Hodnoty ukazovateľov sledovaných v bachorovom obsahujú jalovic sú uvedené v tab. V.

Hodnota pH bachorového obsahu nepatrne poklesla hodinu po podaní lúhovaného jadrového krmiva, neskôr sa opäť priblížila hodnote pred jeho podaním (obr. 1). Pauly et al. (1992) opísali väčšie variácie v pH bachorového obsahu a jeho výraznejší pokles po nakŕmení u šrotovaného ovsa v porovnaní s lúhovaným ovsom. Redukciu diurnálnych zmien pH pripisuje skrmovaniu celého lúhom ošetrovaného ovsa.

Priemerná hodnota pH za sledované časové obdobie je nepatrne vyššia ako horná hranica referenčného rozptatia (Slaniina a kol., 1992), čo je dôsledok kombinovaného účinku skrmovania lúhom ošetrovaného jadrového krmiva a pufracieho účinku vláknito-štruktúrného objemového krmiva.

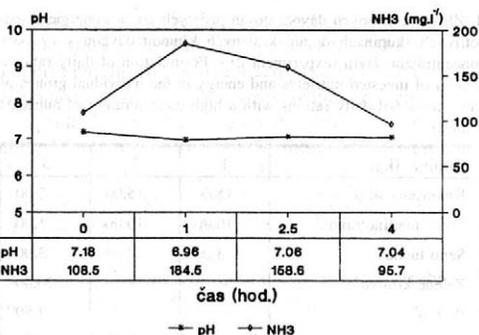
Množstvo amoniaku v bachore hodinu po nakŕmení stúpa. Neskôr má klesajúcu tendenciu – po 2,5 hodinách dosahuje dolnú hranicu referenčných hodnôt (Slaniina a kol., 1992) a po 4 hodinách od podania jadrového krmiva klesá pod uvedené hodnoty (obr. 1). Podobný priebeh v tvorbe amoniakálneho dusíka popísali u fistulovaných kráv Pauly et al. (1992), ktorí vyššiu koncentráciu amoniakálneho dusíka v bachorovej tekutine pripisujú deficiencii ľahko stráviteľných sacharidov pri použití kŕmnej dávky pozostávajúcej len z objemového krmiva a lúhom ošetrovaného ovsa.

Hodnota unikavých mastných kyselín sa hodinu po podaní jadrového krmiva zvýšila a zotrvala vyššia aj štyri hodiny po jeho podaní v porovnaní s východnou hodnotou (obr. 2). Podobný priebeh mala aj tvorba kyseliny octovej a propiónovej. Dosahované hodnoty pri všetkých odberoch boli vyššie ako udávané referenčné

V. Sledované ukazovatele bachorovej fermentácie u jalovic pri skrmovaní lúhovaného krmiva (experiment 1) – Parameters of ruminal fermentation in heifers receiving NaOH treated feed (trial 1)

Ukazovateľ ¹	Odber ⁷ (h)			
	0	1	2,5	4
pH	7,18	6,96	7,06	7,04
NH ₃ mg.l ⁻¹	108,5	184,5	158,6	95,7
K. octová ² mmol.l ⁻¹	73,85	81,3	80,95	83,00
K. propionová ³ mmol.l ⁻¹	27,40	30,25	27,40	28,35
K. maslová ⁴ mmol.l ⁻¹	2,00	1,15	2,00	2,00
K. mliečna ⁵ mmol.l ⁻¹	9,10	7,55	7,70	8,85
UMK ⁶ mmol.l ⁻¹	103,25	112,70	110,35	113,35

¹parameter, ²acetic acid, ³propionic acid, ⁴butyric acid, ⁵lactic acid, ⁶volatile fatty acids, ⁷sampling



1. pH a obsah amoniaku v bachore v časovej závislosti (experiment 1) – pH values and ammonia content in the rumen in relation to time (trial 1)

čas (hod.) = time (hrs)

hodnoty (Slaniina a kol., 1992). V prípade kyseliny mliečnej a maslovej došlo hodinu po podaní jadrového krmiva k poklesu hodnôt. Tieto hodnoty u kyseliny mliečnej postupne stúpali do 4. hodiny po podaní jadrového krmiva a u kyseliny maslovej už po 2,5 hodinách dosahovali východziu hodnotu, ktorá sa udržala aj po 4 hodinách. Všetky zistené hodnoty kyseliny mliečnej boli vyššie a kyseliny maslovej nižšie ako referenčné hodnoty pre uvedené kyseliny.

Experiment 2

Ukazovatele sledované v bachorovom obsahu sú uvedené v tab. VI.

Hodnota pH bachorového obsahu zaznamenala v druhej skupine v porovnaní s prvou skupinou mierny vzostup vplyvom prídavku lúhovanej pšenice. V tretej skupine došlo k nepatrnému poklesu pH v porovnaní

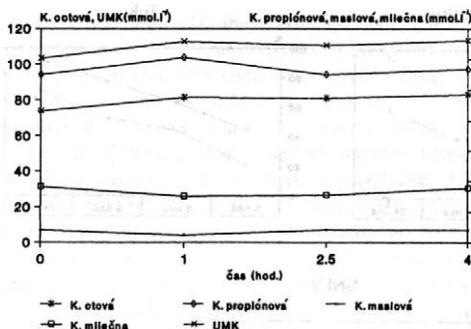
VI. Sledované ukazovatele bachorovej fermentácie u dojnic pri rôznych diétach (experiment 2) – Parameters of ruminal fermentation in dairy cows on different diets (trial 2)

Skupina ¹	1	2	3
pH	6,66	6,84	6,65
NH ₃ mg.l ⁻¹	95,0	82,5	75,1
K. octová ² mmol.l ⁻¹	71,27	60,63	63,33
K. propionová ³ mmol.l ⁻¹	17,97	15,70	16,38
K. maslová ⁴ mmol.l ⁻¹	10,82 ^a	5,73 ^b	6,3 ^b
K. mliečna ⁵ mmol.l ⁻¹	5,37 ^a	9,83 ^c	8,15 ^b
UMK ⁶ mmol.l ⁻¹	105,43	91,84	94,15
C ₂ : C ₃	3,97 : 1	3,86 : 1	3,87 : 1

^{a,b} P < 0,01; ^{a,c} P < 0,001

1 – kontrola, 2, 3 – kŕmne dávky so zaradením lúhovanej pšenice
1 – control, 2, 3 – daily rations containing NaOH treated wheat

¹group; for 2–6 see Tab. V



2. Obsah UMK v bachorovom obsahu jalovic v časovej závislosti (experiment 1) – Contents of volatile fatty acids in the rumen contents of heifers in relation to time (trial 1)

For Figs. 2 and 3: kyselina octová = acetic acid, kyselina propiónová = propionic acid, kyselina maslová = butyric acid, kyselina mliečna = lactic acid, UMK = VFA; čas (hod.) = time (hrs)

s prvou skupinou, čo môžeme považovať za dôsledok zníženia obsahu štruktúrálnej vlákniny pri zaradení zeleného krmiva (jarný typ kŕmnej dávky). Rozdiely medzi skupinami neboli štatisticky významné.

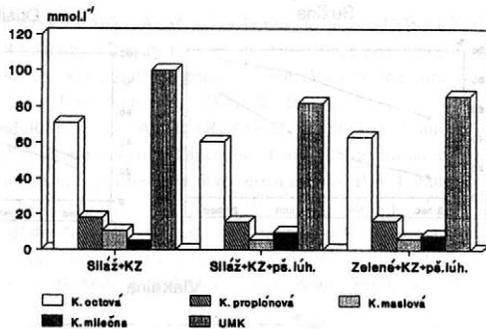
Obsah amoniaku v bachorovom obsahu bol v oboch skupinách s prídavkom lúhovanej pšenice nižší ako v prvej skupine. Najnižšia hodnota bola zistená v tretej skupine. Všetky zistené hodnoty boli nižšie ako dolná hranica referenčného rozpätia (Slanina a kol., 1992). Rozdiely medzi skupinami neboli štatisticky významné. Znížené hodnoty amoniaku pri skrmovaní kukurice ošetrenej lúhom sodným v porovnaní s celým i šrotovaným kukuričným zrnom zaznamenali Anderson et al. (1981).

Pri sledovaní bachorovej fermentácie bol zistený pokles hodnôt kyseliny octovej a propiónovej v oboch skupinách s prídavkom lúhovanej pšenice, pričom nižšie hodnoty oboch ukazovateľov boli namerané v druhej skupine (siláž + lúhovaná pšenica) (obr. 3). Rozdiely neboli štatisticky významné.

Podobná situácia bola aj v prípade kyseliny maslovej, avšak pokles jej hodnôt v druhej a tretej skupine bol štatisticky významný ($P < 0,01$) a uvedené hodnoty boli nižšie ako dolná hranica referenčného rozpätia (Slanina a kol., 1992).

Na rozdiel od predchádzajúcich sledovaní v prípade kyseliny mliečnej došlo k vzostupu hodnôt u oboch skupín s prídavkom lúhovanej pšenice (obr. 3) a rozdiely v porovnaní s prvou skupinou boli štatisticky významné. Zistené hodnoty vo všetkých skupinách boli vyššie ako horná hranica referenčného rozpätia.

Suma unikavých mastných kyselín bola v oboch skupinách s prídavkom lúhovanej pšenice nižšia ako v prvej skupine, kde bola pridaná jadrová zmes bez lúhovaných zŕn. Pokles hodnôt unikavých mastných kyselín, kyseliny propiónovej a maslovej v bachore bol zaznamenaný aj pri skrmovaní lúhovanej kukurice (Anderson et al., 1981).



3. Obsah UMK v bachorovom obsahu dojnic pri rôznych diétach (experiment 2) – Contents of volatile fatty acids in the rumen contents of dairy cows on different diets (trial 2)

Siláž + KZ = silage + concentrate mixture, Siláž + KZ + pš.lúh. = silage + concentrate mixture + NaOH treated wheat, Zelené + KZ + pš.lúh. = green fodder + concentrate mixture + NaOH treated wheat

Experiment 3

Výsledky vyšetrenia stráviteľnosti sušiny, dusíkatých látok, tuku, vlákniny a BNLV sú uvedené v tab. VII a na obr. 4.

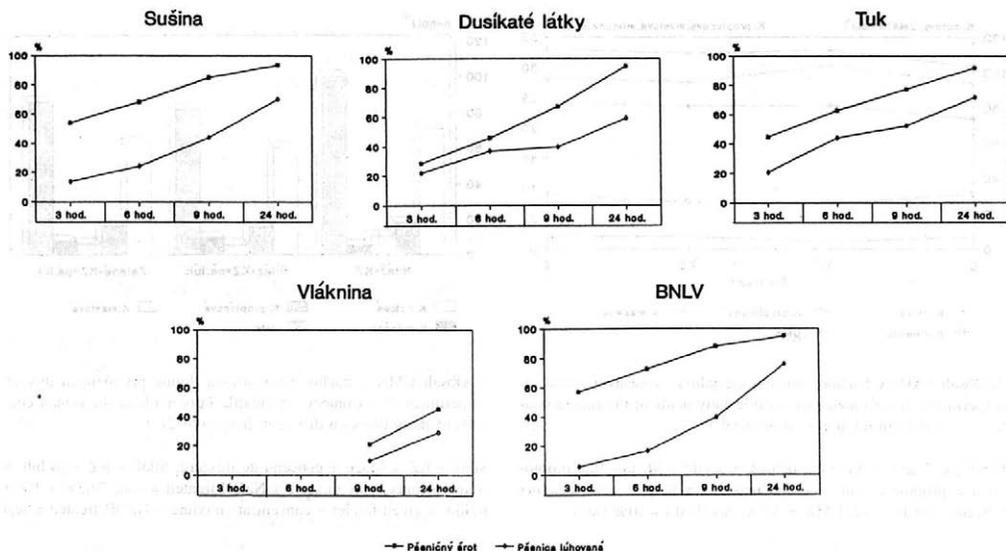
Stráviteľnosť sušiny lúhovanej pšenice po troch hodinách bola podstatne nižšia (17,8 %) ako v prípade

VII. Hodnoty koeficientov stráviteľnosti pšeničného šrotu a lúhovanej pšenice v časovej závislosti stanovené *in situ* (experiment 3) – Values of digestibility coefficients in ground wheat and NaOH treated wheat in relation to time determined *in situ* (trial 3)

Ukazovateľ ¹	Hodiny ⁷	Pšenica lúhovaná ⁸	Pšeničný šrot ⁹
Sušina ²	3	17,8 ^a	53,1 ^c
	6	31,5 ^a	66,5 ^c
	9	41,6 ^a	79,6 ^c
Dusíkaté látky ³	3	21,7 ^a	28,5 ^c
	6	37,0 ^a	45,9 ^c
	9	39,7 ^a	67,2 ^c
Tuk ⁴	3	20,7 ^a	44,6 ^c
	6	44,0 ^a	62,6 ^c
	9	52,2 ^a	77,4 ^c
Vláknina ⁵	3	20,7 ^a	44,6 ^c
	6	44,0 ^a	62,6 ^c
	9	52,2 ^a	77,4 ^c
BNLV ⁶	3	5,7 ^a	57,0 ^c
	6	16,6 ^a	72,7 ^c
	9	39,5 ^a	87,9 ^c
	24	75,9 ^a	94,8 ^c

^a $P < 0,01$; ^b $P < 0,001$

¹parameter, ²dry matter, ³proteins, ⁴fat, ⁵fiber, ⁶nitrogen-free extract, ⁷hours, ⁸NaOH treated wheat, ⁹ground wheat



4. Stráviteľnosť živín sledovaných krmív *in situ* (experiment 3) – Nutrient digestibility in test feeds *in situ* (trial 3)

Sušina = dry matter, Dusíkaté látky = proteins, Tuk = fat, Vlákna = fiber, BNLV = nitrogen-free extract; Pšeničný šrot = ground wheat, Pšenica lúhovaná = NaOH treated wheat

pšeničného šrotu (53,1 %). S pribúdajúcim časom ruminálnej fermentácie sa stráviteľnosť sušiny zvyšovala pri oboch úpravách pšeničného zrna, ale vo všetkých analyzovaných prípadoch bola štatisticky významne vyššia u pšeničného šrotu ($P < 0,001$).

Koeficienty stráviteľnosti dusíkatých látok mali stúpajúcu tendenciu u oboch sledovaných vzoriek s predlžujúcim sa časom uloženia sáčkov v bachore, ale vo všetkých sledovaných časových intervaloch boli štatisticky významne vyššie u pšeničného šrotu ($P < 0,001$). Po 24 hodinách bol rozdiel v stráviteľnosti dusíkatých látok 35,4 % v prospech pšeničného šrotu.

Značný rozdiel v stráviteľnosti tuku bol zistený už po troch hodinách, kedy bol tuk pšeničného šrotu trávený lepšie (o 53,5 %). S postupujúcim časom sa stráviteľnosť tuku u oboch krmív zvyšovala a po 24 hodinách dosahovala u lúhovanej pšenice 71,7 % a u pšeničného šrotu 91,8 %. Vo všetkých časových intervaloch bola stráviteľnosť tuku štatisticky významne vyššia u pšeničného šrotu ($P < 0,001$).

Pri sledovaní trávenia vlákničky sáčkovou metódou boli zistené najnižšie koeficienty stráviteľnosti v porovnaní s ostatnými sledovanými živinami. Vlákna pšeničného šrotu bola trávená lepšie po 9 aj 24 hodinách inkubácie v bachore (koeficient stráviteľnosti 21,0 %, resp. 45,4 %) v porovnaní s lúhovanou pšenicou (koeficient stráviteľnosti 9,83 % resp. 29,2 %), pričom rozdiel po 24hodinovej inkubácii bol štatisticky významný ($P < 0,01$). Koeficienty stráviteľnosti majú stúpajúcu tendenciu u oboch sledovaných krmív s predlžujúcim sa časom trávenia.

Čo sa týka trávenia bezdusíkatých látok výťažkových, najvýraznejší rozdiel (takmer 10násobný) medzi lúhovanou pšenicou a pšeničným šrotom bol zaznamenaný po troch hodinách v prospech pšeničného šrotu. S predlžujúcim sa časom uloženia sáčkov v bachore sa stráviteľnosť BNLV zvyšovala v oboch spomínaných krmivách a po 24 hodinách bol koeficient stráviteľnosti u pšeničného šrotu ešte o 19,9 % vyšší. Vo všetkých sledovaných časových intervaloch bola stráviteľnosť BNLV štatisticky signifikantne vyššia vo vzorkách pšeničného šrotu ($P < 0,001$).

Nižšiu stráviteľnosť lúhovaných zrnín v bachore v porovnaní so šrotovanými zrninami potvrdil aj Berger et al. (1981), ktorí po 24hodinovej inkubácii zistili *in situ* stráviteľnosť sušiny 84,4 % pri ošetrení pšenice 3% lúhom sodným oproti 94,1 % stráviteľnosti sušiny šrotovanej pšenice. Aj Moran (1986) zistil pri 24hodinovej ruminálnej inkubácii u kráv pri použití lúhovaného ovsu nižší úbytok sušiny ako pri použití ovsu šrotovaného. Podobný priebeh stráviteľnosti sušiny, ako sme pri bachorovej inkubácii pšenice v rôznych časových intervaloch zistili v našom pokuse, popísali aj Pauly et al. (1992) u ovsu ošetreného 3% a 5% lúhom sodným a ovsu drveného.

Z uvedených údajov vyplýva, že v porovnaní so šrotovanými zrninami sú obiloviny ošetrené lúhom trávené pomalšie. Ako uvádzajú Pauly et al. (1992), lúh sodný mení štruktúru amylázy a/alebo amylopektínu takým spôsobom, že ich enzymatická degradácia je spomalená alebo, pravdepodobnejšie, pH alebo bakteriostatický efekt samotného lúhu vedie k zníženiu bak-

teriálneho účinku na škrobové zrná. Pri hodnotení stráviteľnosti je potrebné brať do úvahy aj fyzikálnu štruktúru obilovín – hodnoty koeficientov stráviteľnosti jednotlivých živín sú nižšie u lúhovanej pšenice inkubovanej v celých zrnách ako u pšenice šrotovanej.

Lúhom ošetrované celé zrna majú vyššiu rýchlosť pasáže vďaka rýchlej sedimentácii v retikule a následne väčšiu možnosť pasáže do omasu a abomasu, čo môže viesť k vysokým dávkam škrobu vstupujúcim do tenkého čreva. Nocek a Tamminga (1991) uvádzajú, že čím viac škrobu unikne z bachora, tým vyššie bude jeho posttruminálne trávenie.

Prednosťou použitia lúhu sodného na ošetrovanie zrnín je, že kombináciou tepla, silnej zásady a mechanického pôsobenia miešacieho voza dochádza k narušeniu obilky zrna a sprístupneniu živín bachorovej mikroflóre. Môžu byť použité nešrotované obilniny z vlastných zásob, i s vyšším obsahom vlhkosti, pretože vysoké pH krmiva po lúhovaní bráni rozvoju toxických plesní počas skladovania. Pri trávení lúhom ošetrovaného zrna dochádza k spomaleniu fermentácie škrobu a posilneniu schopnosti neutralizovať kyslosť v bachore účinkom bikarbonátu sodného vznikajúceho pri lúhovaní.

LITERATÚRA

- ANDERSON, G. D. – BERGER, L. L. – FAHEY, G. C. : Alkali treatment of cereal grains. II. Digestion, ruminal measurements and feedlot performance. *J. Anim. Sci.*, 52, 1981: 144–149.
- BERGER, L. – KLOPFENSTEIN, T. – BRITTON, R. : Effect of sodium hydroxide on efficiency of rumen digestion. *J. Anim. Sci.*, 49, 1979: 1317–1323.
- BERGER, L. L. – ANDERSON, G. D. – FAHEY, G. C., Jr. : Alkali treatment of cereal grains. I. *In situ* and *in vitro* evaluation. *J. Anim. Sci.*, 52, 1981: 138–143.

CHIMOWANO, A. M. – ORSKOV, E. R. – STEWART, C. S.: Effect of dietary proportion of roughage and concentrate on the rate of dried grass disappearance in the rumen of sheep. *Proc. Nutr. Soc.*, 35, 1976: 101 A.

McRAE, J. C. – ARMSTRONG, D. G.: Studies on intestinal digestion in sheep II. Digestion of some carbohydrate constituents in hay, cereal and hay-cereal rations. *Brit. J. Nutr.*, 23, 1969: 377–382.

MORAN, J. B.: Cereal grain in complete diets for dairy cows: a comparison of rolled barley, wheat and oat and of three methods of processing oats. *Anim. Prod.*, 43, 1986: 217.

NOCEK, J. E. – TAMMINGA, S.: Site of digestion of starch in the gastrointestinal tract of dairy cows and its effect on milk yield and composition. *J. Dairy Sci.*, 74, 1991: 3598–3629.

ORSKOV, E. R. – GREENHALGH, J. F. D.: Alkali treatment as a method of processing whole grain for cattle. *J. Agric. Sci.*, 89, 1977: 253–255.

ORSKOV, E. R. – SOLIMAN, H. S. – MacDEARMID, A.: Intake of hay by cattle given supplements of barley subjected to various forms of physical treatment with alkali. *J. Agric. Sci.*, 90, 1978: 611–615.

PAULY, T. – SPÖRNDLY, R. – UDEN, P.: Rumen degradability *in sacco* of physically and chemically treated oat and barley grain. *J. Sci. Fd Agric.*, 58, 1992: 465–473.

SLANINA, L. a kol.: Metabolický profil hovädzieho dobytku vo vzťahu k zdraviu a produkcii. 2. doplnené a prepracované vyd. Bratislava 1992. 115 s.

VESELÝ, P.: Stráviteľnosť briketovanej kompletnej smesi s rôznou upravenou obilninou. *Živoč. Výr.*, 39, 1994: 895–902.

Došlo 3. 2. 1998

Prijaté k publikovaniu 19. 5. 1998

Kontaktná adresa:

MVDr. Mária Demeterová, CSc., Univerzita veterinárskeho lekárstva, Komenského 73, 041 81 Košice, Slovenská republika, tel.: ++ 421/95/633 56 34, fax: ++ 421/95/632 36 66, e-mail: demeter@vsvnov.uvm.sk

Oznamujeme čtenářům a autorům našeho časopisu,

že v návaznosti na časopis *Scientia agriculturae bohemoslovaca*, který až do roku 1992 vycházel v Ústavu vědeckotechnických informací Praha, vydává od roku 1994

Česká zemědělská univerzita v Praze

časopis

SCIENTIA AGRICULTURAE BOHEMICA

Časopis si zachovává původní koncepci reprezentace naší vědy (zemědělství, lesnictví, potravinářství) v zahraničí a jeho obsahem jsou původní vědecké práce uveřejňované v angličtině s rozšířenými souhrny v češtině.

Časopis je otevřen nejširší vědecké veřejnosti a redakční rada nabízí možnost publikace pracovníkům vysokých škol, výzkumných ústavů a dalších institucí vědecké základny.

Příspěvky do časopisu (v angličtině, popř. v češtině či slovenštině) posílejte na adresu:

**Česká zemědělská univerzita v Praze
Redakce časopisu *Scientia agriculturae bohemica*
165 21 Praha 6-Suchdol**

USE OF RAPESEED MEAL AND LECITHIN SLOPS IN DIETS FOR BROILER CHICKS*

VYUŽITÍ ŘEPKOVÉHO EXTRAHOVANÉHO ŠROTU A LECITINOVÝCH KALŮ VE VÝŽIVĚ KUŘECÍCH BROJLERŮ

P. Zobač¹, I. Kumprecht¹, V. Prokop¹, J. Čmolík²

¹Research Institute of Animal Nutrition, s.r.o., Pohořelice, Czech Republic

²SETUZA a.s., Ústí nad Labem, Czech Republic

ABSTRACT: Three comparative feeding trials were conducted on cockerels of ROSS hybrid. The effect of two levels of rapeseed meal (RM) enriched with 1% of lecithin slops (LS) and of enzymic concentrate ALLZYME VEGPRO (AVC) was studied as exerted on broiler weight and feed consumption. The effect of the higher RMLS level (a_2) on broiler weight was positive and significant ($P < 0.05$) at 21 days of age (+ 6.45%). No statistically significant differences between the experimental groups were determined at 35 and 42 days of age. The enzymic concentrate AVC did not have any statistically significant effect on broiler weight in the separate periods of observation. Feed consumption per 1 kg of weight gain was significantly ($P < 0.05$) higher in feed mixtures BR2 containing 12.12% RMLS (a_2) (+5.04%). Total feed consumption per 1 kg of weight gain was higher on average by 2.5% in groups ($a_2 + a_3$) receiving feeds with RMLS. The effect of enzymic concentrate AVC on total feed consumption per 1 kg of weight gain was not statistically significant. The second trial was focused on the effect of two RM levels and AVC on broiler weight. The weight of broilers receiving feeds with different RM levels was comparable with the weight of broilers in control group (a_0). The final broiler weight was not influenced by significant differences ($P < 0.05$) between the weight of broilers a_1 and a_2 . The groups of broilers on diets with enzymic concentrate AVC (b_1) had insignificantly higher weights (+2.13%) at the end of trial than did the broilers receiving feeds without any concentrate (b_0). The effect of RM application to feed mixtures BR1 and BR2 at 6% (a_1) and 12% (a_2) levels on feed consumption per 1 kg of weight gain was highly significantly ($P < 0.01$) negative in comparison with control (a_0). The enzymic concentrate AVC did not influence the total average feed consumption per 1 kg of weight gain. The third trial was conducted to determine the effect of experimental levels of lecithin slops and the effect of enzymic concentrate AVC on broiler weight. The effect of 1% LS application to RM on broiler weight was positive in all experimental periods. The broilers of group (a_2) had significantly ($P < 0.1$) higher weight at 35 days of age than the broilers of group (a_0). The cockerels of group (a_2) had by 5.04% higher weight at 42 days of age at the end of trial than the individuals of group (a_0). The cockerels which received diets with AVC concentrate showed by 3.02% higher average weight at 42 days of age than group (a_0). Lecithin slops reduced feed consumption per 1 kg of weight gain significantly ($P < 0.05$) to highly significantly ($P < 0.01$). Slightly negative effects of LS use on feed consumption were determined in feed mixtures BR1 only. Total feed consumption per 1 kg of weight gain was lowest in group (a_2), which received RM with LS at a 1% concentration. The application of enzymic concentrate AVC resulted in a significant ($P < 0.1$) positive decrease in the consumption of feed mixture BR2 per 1 kg of weight gain. There were no differences in total feed consumption per 1 kg of weight gain, and the values were in the range of natural variability.

broiler chicks; rapeseed meal; lecithin slops; ALLZYME VEGPRO concentrate; growth; feed consumption

ABSTRAKT: Byly provedeny tři krmné srovnávací pokusy s kohoutky hybrida ROSS. Vliv dvou hladin řepkového extra-hovaného šrotu (ŘEŠ) obohaceného 1 % lecitinových kalů (LK) a enzymového preparátu ALLZYME VEGPRO Concentrate (AVC) na hmotnost kuřat v prvním pokusu je uveden v tab. IV. Hmotnost kuřat byla pozitivně průkazně ($P < 0,05$) ovlivněna vyšší hladinou ŘEŠLK (a_2) (+6,45 %) v 21. dni věku. V 35. a 42. dni věku nebyl zaznamenán statisticky významný rozdíl mezi sledovanými skupinami. Enzymový preparát AVC statisticky významně neovlivnil hmotnost kuřat v jednotlivých sledovaných periodách. Spotřeba směsi na 1 kg přírůstku (tab. V) byla průkazně ($P < 0,05$) vyšší u směsi BR2 s hladinou 12,12% ŘEŠLK (a_2) (+5,04%). Celková spotřeba směsi byla na 1 kg přírůstku v průměru o 2,5 % vyšší u skupin (a_2, a_3) krmných směsí s ŘEŠLK. Enzymový preparát AVC statisticky významně neovlivnil celkovou spotřebu směsi na 1 kg přírůstku. Účinek aplikace dvou různých hladin ŘEŠ a enzymového preparátu AVC na hmotnost kuřat v druhém pokusu je uveden v tab. VI. Hmotnost kuřat krmných směsí s různou hladinou ŘEŠ byla srovnatelná s hmotností kuřat skupiny kontrolní (a_0). Průkazné rozdíly ($P < 0,05$) mezi hmotností kuřat skupin a_1 a a_2 neměly vliv na konečnou hmotnost kuřat. Skupiny

* This project was supported by the Ministry of Agriculture of CR (Project No. EP 7012 of the National Agency for Agricultural Research).

kuřat krmených směsí s enzymovým preparátem AVC (b_1) měly neprůkazně vyšší hmotnost (+2,13 %) na konci pokusu oproti kuřatům krmených směsí bez tohoto preparátu (b_0). Spotřeba směsí na 1 kg přírůstku (tab. VII) byla vysoce průkazně ($P < 0,01$) negativně ovlivněna zařazením ŘEŠ do krmných směsí BR1 a BR2, jak v množství 6 % (a_1), tak i v množství 12 % (a_2), oproti kontrole (a_0). Enzymový preparát AVC neovlivnil v průměru celkovou spotřebu směsí na 1 kg přírůstku. Vliv použitých hladin lecitinových kalů a vliv enzymového preparátu AVC na hmotnost kuřat v třetím pokusu je uveden v tab. VIII. Aplikace 1 % LK do ŘEŠ pozitivně ovlivnila hmotnost kuřat ve všech sledovaných obdobích. V 35. dni věku byla zaznamenána průkazně ($P < 0,1$) vyšší hmotnost kuřat u skupiny a_2 oproti skupině a_0 . Na konci pokusu (ve 42. dni věku kuřat) měli kohoutci skupiny a_2 o 5,04 % vyšší hmotnost oproti skupině a_0 . Kohoutci, jimž byl aplikován do směsí preparát AVC (b_1), měli ve 42. dni věku o 3,02 % vyšší průměrnou hmotnost oproti skupině a_0 . Lecitinové kaly průkazně ($P < 0,05$) až vysoce průkazně ($P < 0,01$) snížily spotřebu směsí na 1 kg přírůstku (tab. IX). Mírně negativní vliv LK na spotřebu směsí byl zaznamenán pouze v případě zkrmování směsí BR1. Celková spotřeba směsí na 1 kg přírůstku byla nejnižší u skupiny (a_2), ve které byly aplikovány LK v koncentraci 1 % na ŘEŠ. Enzymový preparát AVC průkazně ($P < 0,1$) snížil spotřebu směsí BR2 na 1 kg přírůstku. V celkové spotřebě směsí na 1 kg přírůstku nebyly zjištěny žádné rozdíly a hodnoty se pohybovaly v mezích přirozené variability.

kuřecí brojeři; řepkový extrahovaný šrot; lecitinové kaly; ALLZYME VEGPRO Concentrate; růst; spotřeba krmiv

INTRODUCTION

The use of rapeseed meals in diets for monogastric animals provided controversial results in the past. Original research aimed at application of this feed to complete feed mixtures indicated problems resulting from high contents of glucosinolates, and mainly of erucic acid. Even though a substantial portion of erucic acid gets to pressed oil, glucosinolates do remain in rapeseed meal. New rape varieties bred in the eighties and the present zero-erucic varieties '00' provide feed with a substantially lower glucosinolate content than in the original '0' varieties. Positive results of rapeseed feeding to broiler chicks were reported by Lessire et al. (1993), Daenicke et al. (1994), Schöne et al. (1993) and Schlöffel et al. (1993).

The rape has been a crop of concern in the sectors of breeding and seed production, cultural practices, oleo-program and biofuel in this country in the last 12–15 years. Hardly any attention has been paid to rape use in the feed sector when rapeseed feeds were used in animal diets to a minimum extent. Therefore the bulk of rapeseed meals is exported although rapeseed use for animal nutrition is apparently economically advantageous. If the nutritive value of rapeseed feeds is estimated at 75–80% of that of soya feeds, the cost of rapeseed feeds is only 55–65% of soya cost. Increases in soya feed and grain prices make this problem still more urgent. The present quality of domestic soybean meals is high, complying with glucosinolate limits for '00' rapes established not only by Czech standards but also by French regulations stricter by 50%.

Výmola et al. (1995) and Haščík et al. (1994) have recently studied the use of rapeseed cake for broiler production. Kadlec et al. (1994) tested the use of rape cake in combination with AMP 50 preparation in feed mixtures for broiler production with a reduced protein content.

The objective of this paper was to study the use of L-lysine enriched rapeseed meal as a partial replacement of soybean meal in broiler starters and feed mix-

tures. Parallel studies were aimed at the effect of lecithin slops applied as a supplementary energy source and of enzymic concentrate ALLZYME VEGPRO used as a biocatalyst for protein breakdown and fat splitting.

MATERIAL AND METHODS

Trials on broiler chicks were conducted to study the effect of rapeseed meals (RM) used as a replacement of soybean meal (SM) and of lecithin slops (LS) on broiler performance. An enzymic concentrate ALLZYME VEGPRO (AVC) was also applied to experimental diets to increase the nutritive value of rapeseed meal.

Experimental diets for broiler chicks consisted of:

- Rapeseed meals obtained from SETUZA company at Ústí nad Labem with the following chemical composition:

Component	Unit	Determined value
Dry matter	%	88.59
Ash	%	6.65
Organic matter	%	81.94
Fat	%	2.09
Protein	%	32.90
Fiber	%	11.63
Nitrogen-free extract	%	35.32
Erucic acid	%	0.14
Glucosinolates	μmol/g	21.0

- Lecithin slops obtained from SETUZA company at Ústí nad Labem with the following chemical composition:

Parameter	Unit	Determined value
Water content	%	48.9
Impurity content	%	1.65
Fat content	%	49.45
Phosphorus content	g/kg fat	13.4
Acid number	mg KOH/g	31.6

Enzymic concentrate ALLZYME VEGPRO manufactured by ALLTECH, inc. USA, containing proteolytic enzymes, enzymes hydrolyzing nonstarch polysaccharides and lipases.

Three comparative feeding trials were conducted on cockerels of ROSS hybrid supplied by the Company MACH Chick Hatcheries at Litomyšl. Broilers were divided into cages of an experimental house of the Pohořelice research institute: 20 chicks per cage from the 1st day of life and 10 chicks per cage from the 22nd day of life. A total of 240 cockerels were used in the trials in agreement with experimental factors. Broilers received feed mixtures BR1 from 1 to 21 days of age and feed mixtures BR2 from 22 to 42 days of age.

A two-factor design with replication according to the formula A (3) x B (2) x (40) was used in these trials.

Trial 1

The objective of the trial was to compare the effect of two levels of RM enriched with 1% LS and of enzymic concentrate AVC on broiler weight and feed consumption when:

F (A) was represented by RM + LS:

a₀ - 0% RM + 0% LS

a₁ - 6% RM + 0.06% LS

a₂ - 12% RM + 0.12% LS

F (B) by enzymic concentrate AVC:

b₀ - 0 g AVC/100 kg feed

b₁ - 5 g AVC/100 kg feed

Formulation of experimental diets and nutrient contents are given in Tab. I.

I. Formulation and nutrient contents of feed mixtures BR1 and BR2 in Trial 1

Ingredient	Diet designation											
	a ₀ b ₀		a ₀ b ₁		a ₁ b ₀		a ₁ b ₁		a ₂ b ₀		a ₂ b ₁	
	BR1	BR2										
	percentage proportion											
Fish meal	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5
Meat-bone meal	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5
Soybean meal	18	17	18	17	9.6	8.8	9.6	8.8	4.8	4.0	4.8	4.0
Rapeseed meal	0	0	0	0	6	6	6	6	12	12	12	12
Corn	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5
Wheat	15.3	16.8	15.3	16.8	14.9	16.4	14.9	16.4	14.5	16	14.5	16
Soya extrudate	14	15	14	15	14	15	14	15	14	15	14	15
Wheat starch	0	0	0	0	2.4	2.2	2.4	2.2	1.2	1	1.2	1
Feeding limestone	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Dicalcium phosphate	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Feeding salt	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20% Lys HCl premix	0	0	0	0	0.4	0.4	0.4	0.4	0.8	0.8	0.8	0.8
¹ Aminovitan BR1 Plus	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-
² Aminovitan BR2 Plus	-	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-	0.5
LS in g/100 kg	0	0	0	0	60	60	60	60	120	120	120	120
Enzymic concentrate AVC g/100 kg	0	0	5	5	0	0	5	5	0	0	5	5
Dry matter %	88.67	88.53	88.67	88.53	88.80	88.65	88.80	88.65	88.81	88.66	88.81	88.66
Proteins %	24.80	22.47	24.80	22.47	23.24	21.00	23.24	21.00	23.24	21.00	23.24	21.00
Fat %	5.59	5.69	5.59	5.69	5.61	5.71	5.61	5.71	5.67	5.77	5.67	5.77
Fiber %	3.70	3.75	3.70	3.75	3.84	3.91	3.84	3.91	4.24	4.27	4.24	4.27
Ash %	4.55	4.59	4.55	4.59	4.42	4.46	4.42	4.46	4.50	4.54	4.50	4.54
ME MJ/kg	12.50	12.56	12.50	12.56	12.54	12.58	12.54	12.58	12.36	12.41	12.36	12.41

¹ Vitamin A 2,700,000 i.u., vitamin D₃ 700,000 i.u., vitamin E 10,000 mg, vitamin K₃ 600 mg, vitamin B₁ 400 mg, vitamin B₂ 1,000 mg, vitamin B₆ 900 mg, vitamin B₁₂ 5 mg, niacin 8,000 mg, calcium pantothenate 2,500 mg, biotin 20 mg, folic acid 200 mg, choline 60,000 mg, antioxidant (Endox) 20,000 mg, DL-methionine 400,000 mg, Robenidin 6,600 mg, cobalt 72 mg, copper 1,570 mg, iron 7,500 mg, iodine 120 mg, manganese 15,800 mg, zinc 10,700 mg, selenium 32 mg

² Vitamin A 2,400,000 i.u., vitamin D₃ 500,000 i.u., vitamin E 7,000 mg, vitamin K₃ 500 mg, vitamin B₁ 400 mg, vitamin B₂ 1,000 mg, vitamin B₆ 600 mg, vitamin B₁₂ 4 mg, niacin 5,000 mg, calcium pantothenate 2,000 mg, choline 40,000 mg, antioxidant (Endox) 20,000 mg, DL-methionine 360,000 mg, Maduramycin 1,000 mg, cobalt 66 mg, copper 1,400 mg, iron 6,800 mg, iodine 110 mg, manganese 14,400 mg, zinc 10,000 mg, selenium 30 mg

Trial 2

The objective of the trial was to compare the effect of two levels of RM and of enzymic concentrate AVC on broiler weight and feed consumption per 1 kg of weight gain.

F (A) was represented by RM:

a_0 - 0% RM

a_1 - 6% RM

a_2 - 12% RM

F (B) by enzymic concentrate AVC:

b_0 - 0 g AVC/100 kg feed

b_1 - 5 g AVC/100 kg feed

Formulation of experimental diets and nutrient contents are given in Tab. II.

Trial 3

The trial was conducted to study the effect of two levels of LS applied to RM at concentrations 0.5% and 1% at a constant RM level in feed mixtures BR1 and BR2 and of enzymic concentrate AVC

F (A) Lecithin slops:

a_0 - 0 g LS/100 kg feed

a_1 - 30 g LS/100 kg feed

a_2 - 60 g LS/100 kg feed

F (B) by enzymic concentrate AVC:

b_0 - 0 g AVC/100 kg feed

b_1 - 5 g AVC/100 kg feed

Formulation of feed mixtures and nutrient contents are given in Tab. III.

The efficiency of RM was compared with that of soybean meal (SM) adjusted to the level of rapeseed meal proteins. Lysine deficiency in RM was eliminated by application of 20% lysine premix to experimental diets.

Constant conditions for broiler production were maintained in the trials - continuous illumination, feed and water intake *ad libitum*. Air temperature and atmospheric humidity were controlled according to the rules for broiler production.

Broiler weight in g and feed consumption in kg per 1 kg of weight gain were determined by weighing on days 1, 21, 35 and 42 of age. Longitudinal recording of feed consumption was practised.

Chemical analyses of feeds were made in agreement with procedures laid down by the standard CSN 46 7092 (1985). Multifactorial analysis of variance was used for data processing (Snedecor, Cochran, 1969).

II. Formulation and nutrient contents in feed mixtures BR1 and BR2 in Trial 2

Ingredient	Diet designation											
	a_0b_0		a_0b_1		a_1b_0		a_1b_1		a_2b_0		a_2b_1	
	BR1	BR2	BR1	BR2	BR1	BR2	BR1	BR2	BR1	BR2	BR1	BR2
percentage proportion												
Fish meal	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5
Meat-bone meal	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5
Soybean meal	18	17	18	17	9.6	8.8	9.6	8.8	4.8	4	4.8	4
Rapeseed meal	0	0	0	0	6	6	6	6	12	12	12	12
Corn	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5
Wheat	15.3	16.8	15.3	16.8	14.9	16.4	14.9	16.4	14.5	16	14.5	16
Soya extrudate	14	15	14	15	14	15	14	15	14	15	14	15
Wheat starch	0	0	0	0	2.4	2.2	2.4	2.2	1.2	1	1.2	1
Feeding limestone	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Dicalcium phosphate	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Feeding salt	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20% Lys HCl premix	0	0	0	0	0.4	0.4	0.4	0.4	0.8	0.8	0.8	0.8
¹⁾ Aminovitan BR1 Plus	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0
²⁾ Aminovitan BR2 Plus	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0	0.5
Enzymic concentrate AVC g/100 kg	0	0	5	5	0	0	5	5	0	0	5	5
Dry matter %	88.67	88.53	88.67	88.53	88.76	88.61	88.76	88.61	88.77	88.62	88.77	88.62
Proteins %	24.80	22.47	24.80	22.47	23.24	21.00	23.24	21.00	24.24	21.00	23.24	21.00
Fat %	5.59	5.69	5.59	5.69	5.57	5.67	5.57	5.67	5.61	5.71	5.61	5.71
Fiber %	3.70	3.75	3.70	3.75	3.84	3.90	3.84	3.90	4.24	4.27	4.24	4.27
Ash %	4.55	4.59	4.55	4.59	4.42	4.46	4.42	4.46	4.50	4.54	4.50	4.54
ME MJ/kg	12.50	12.56	12.50	12.56	12.53	12.57	12.53	12.57	12.34	12.39	12.34	12.39

¹⁾ The legend see Tab. I

²⁾ The legend see Tab. I

Ingredient	Diet designation											
	a ₀ b ₀		a ₀ b ₁		a ₁ b ₀		a ₁ b ₁		a ₂ b ₀		a ₂ b ₁	
	BR1	BR2										
	percentage proportion											
Fish meal	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5	4	1.5
Meat-bone meal	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5	5.5	3.5
Soybean meal	9.6	8.8	9.6	8.8	9.6	8.8	9.6	8.8	9.6	8.8	9.6	8.8
Rapeseed meal	6	6	6	6	6	6	6	6	6	6	6	6
Corn	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5	41.9	44.5
Wheat	14.9	16.4	14.9	16.4	14.9	16.4	14.9	16.4	14.9	16.4	14.9	16.4
Soya extrudate	14	15	14	15	14	15	14	15	14	15	14	15
Wheat starch	2.4	2.2	2.4	2.2	2.4	2.2	2.4	2.2	2.4	2.2	2.4	2.2
Feeding limestone	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Dicalcium phosphate	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5	0.3	0.5
Feeding salt	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20% Lys HCl premix	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
¹⁾ Aminovitan BR1 Plus	0.5	—	0.5	—	0.5	—	0.5	—	0.5	—	0.5	—
²⁾ Aminovitan BR2 Plus	—	0.5	—	0.5	—	0.5	—	0.5	—	0.5	—	0.5
LS in g/100 kg	0	0	0	0	30	30	30	30	60	60	60	60
Enzymic concentrate AVC g/100 kg	0	0	5	5	0	0	5	5	0	0	5	5
Dry matter %	88.76	88.61	88.76	88.61	88.78	88.63	88.78	88.63	88.80	88.65	88.80	88.65
Proteins %	23.24	21.00	23.24	21.00	23.24	21.00	23.24	21.00	23.24	21.00	23.24	21.00
Fat %	5.57	5.67	5.57	5.67	5.59	5.69	5.59	5.69	5.61	5.71	5.61	5.71
Fiber %	3.84	3.90	3.84	3.90	3.84	3.90	3.84	3.90	3.84	3.91	3.84	3.91
Ash %	4.42	4.46	4.42	4.46	4.42	4.46	4.42	4.46	4.42	4.46	4.42	4.46
ME MJ/kg	12.53	12.57	12.53	12.57	12.53	12.57	12.53	12.57	12.54	12.58	12.54	12.58

¹⁾ The legend see Tab. I
²⁾ The legend see Tab. I

RESULTS

Tab. IV illustrates the effect of two levels of rapeseed meal enriched with 1% LS and of enzymic concentrate AVC on broiler weight. The effect of a higher RMLS level (a₂) on broiler weight at 21 days of age was positively significant (+6.45%). But the difference between the experimental groups at 35 and 42 days of age was not statistically significant (P < 0.05). The enzymic concentrate AVC did not have any statistically significant effect on broiler weight in the experimental periods. Feed consumption per 1 kg of weight gain from day 22 to day 42 (Tab. V) was significantly (P < 0.05) higher for mixtures BR2 with a 12.12% RMLS level (a₂) (+5.04%). Total feed consumption per 1 kg of weight gain from day 1 to day 42 was on average by 2.5% higher in groups (a₁, a₂) receiving feeds with RMLS. The enzymic concentrate AVC did not have any statistically significant effects on total feed consumption per 1 kg of weight gain.

The effect of two RM levels and enzymic concentrate AVC on broiler weight in Trial 2 is shown in Tab. VI. The weight of broilers receiving diets with different RM levels was comparable with the weight of broilers in control group (a₀). Significant differences (P < 0.05)

between the weight of broilers a₁ and a₂ did not influence the final weight of broilers. Groups of broilers receiving diets with enzymic concentrate AVC (b₁) had insignificantly higher weight (+2.13%) at the end of trial than did the broilers on diets without any concentrate (b₀).

The use of RM in feed mixtures BR1 and BR2 at both levels of 6% (a₁) and 12% (a₂) had highly significantly (P < 0.01) negative effects on feed consumption per 1 kg of weight gain (Tab. VII) in comparison with control (a₀). The enzymic concentrate AVC did not have any effect on total feed consumption per 1 kg of weight gain in general.

Tab. VIII shows the effect of experimental levels of lecithin slops and the effect of enzymic concentrate AVC on broiler weight in Trial 3. The effects of application of 1% LS to RM on broiler weight were positive in all experimental periods. The broilers of group (a₂) at 35 days of age had significantly (P < 0.1) higher weight than those of group (a₀). The cockerels of group (a₂) had by 5.04% higher weight at 42 days of age at the end of trial than group (a₀). The cockerels that received diets with AVC concentrate (b₁) had by 3.02% higher average weight at 42 days of age than did group (b₀).

IV. The effect of different levels of RM enriched with 1% lecithin slops and of enzymic concentrate AVC on broiler weight in Trial I

Parameter	Unit	RM + LS			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
Broiler number		80	80	80	120	120
Weight on day 1	g	51	50	52	51	51
Weight on day 21	g	589 ^a	596 ^{ab}	627 ^b	609	599
S.D.	g	± 85	± 83	± 94	± 89	± 89
Index	%	100.00	101.19	106.45	100.00	98.36
Weight on day 35	g	1 431	1 434	1 441	1 430	1 441
S.D.	g	± 200	± 191	± 193	± 196	± 192
Index	%	100.00	100.21	100.70	100.00	100.77
Weight on day 42	g	1 924	1 938	1 925	1 922	1 935
S.D.	g	± 259	± 269	± 249	± 265	± 251
Index	%	100.00	100.73	100.05	100.00	100.68

Legend for Tabs. IV and V:

a₀ - 0% RM LS

a₁ - 6.06% RM LS

a₂ - 12.12% RM LS

b₀ - 0 g AVC/100 kg feed

b₁ - 5 g AVC/100 kg feed

Small letters designate significantly different values at $P < 0.05$

V. The effect of different levels of RM enriched with 1% LS and of enzymic concentrate AVC on feed consumption (in kg) per 1 kg of weight gain in Trial I

Parameter	Unit	RM + LS			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
Group number		8	8	8	12	12
BR1 mixture consumption from day 1 to day 21	kg	1.521	1.549	1.482	1.485 ^a	1.550 ^b
S.D.	kg	± 0.049	± 0.078	± 0.066	± 0.053	± 0.069
Index	%	100.00	101.84	97.43	100.00	104.38
BR2 mixture consumption from day 22 to day 35	kg	1.776 ^a	1.832 ^{ab}	1.888 ^b	1.844	1.821
S.D.	kg	± 0.028	± 0.043	± 0.104	± 0.099	± 0.055
Index	%	100.00	103.15	106.30	100.00	98.75
BR2 mixture consumption from day 22 to day 42	kg	1.902 ^a	1.934 ^{ab}	1.998 ^b	1.946	1.942
S.D.	kg	± 0.036	± 0.031	± 0.072	± 0.074	± 0.052
Index	%	100.00	101.68	105.04	100.00	99.79
Total feed consumption from day 1 to day 35	kg	1.676	1.719	1.719	1.696	1.713
S.D.	kg	± 0.027	± 0.043	± 0.041	± 0.038	± 0.045
Index	%	100.00	102.57	102.56	100.00	101.00
Total feed consumption from day 1 to day 42	kg	1.791 ^a	1.821 ^{ab}	1.838 ^b	1.807	1.826
S.D.	kg	± 0.026	± 0.033	± 0.037	± 0.035	± 0.037
Index	%	100.00	101.68	102.62	100.00	101.05

Lecithin slops decreased feed consumption per 1 kg of weight gain significantly ($P < 0.05$) to highly significantly ($P < 0.01$) (Tab. IX). A slightly negative effect of LS on feed consumption was observed in BR1 feed mixtures only.

Total feed consumption per 1 kg of weight gain was lowest in group (a₂), which received LS applied to RM at a 1% concentration. The enzymic concentrate AVC significantly ($P < 0.1$) decreased the consumption of

BR2 mixtures per 1 kg of weight gain. There were no differences in total feed consumption per 1 kg of weight gain, and the values were in the range of natural variability.

DISCUSSION

As shown by the experimental data, it is possible to use rapeseed meal in broiler diets successfully in case

VI. The effect of two RM levels and enzymic concentrate AVC on broiler weight in Trial 2

Parameter	Unit	RM			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
Broiler number		80	80	80	120	120
Weight on day 1	g	51	50	51	51	51
Weight on day 21	g	589	584	616	592	601
S.D.	g	± 85	± 90	± 99	± 90	± 94
Index	%	100.00	99.15	104.58	100.00	101.52
Weight on day 35	g	1 431 ^{ab}	1 360 ^a	1 447 ^b	1 400	1 424
S.D.	g	± 200	± 217	± 219	± 204	± 225
Index	%	100.00	95.03	101.12	100.00	101.71
Weight on day 42	g	1 924	1 845	1 929	1 879	1 919
S.D.	g	± 259	± 256	± 278	± 256	± 276
Index	%	100.00	95.89	100.26	100.00	102.13

Legend for Tabs. VI and VII:

a₀ - 0% RM

a₁ - 6% RM

a₂ - 12% RM

b₀ - 0 g AVC/100 kg feed

b₁ - 5 g AVC/100 kg feed

Small letters designate significantly different values at $P < 0.05$

VII. The effect of two RM levels and enzymic concentrate AVC on BR1 and BR2 mixture consumption (in kg) per 1 kg of weight gain in Trial 2

Parameter	Unit	RM			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
Group number		8	8	8	12	12
Days 1-21	kg/kg	1.676 ^A	1.765 ^C	1.717 ^B	1.718	1.720
S.D.	kg/kg	± 0.049	± 0.012	± 0.019	± 0.023	± 0.041
Index	%	100.00	105.31	102.45	100.00	100.12
Days 22-35	kg/kg	1.776 ^A	1.946 ^C	1.877 ^B	1.871	1.862
S.D.	kg/kg	± 0.028	± 0.053	± 0.034	± 0.093	± 0.070
Index	%	100.00	109.57	105.68	100.00	99.52
Days 22-42	kg/kg	1.902 ^A	2.018 ^B	1.979 ^B	1.972	1.961
S.D.	kg/kg	± 0.036	± 0.060	± 0.032	± 0.080	± 0.048
Index	%	100.00	106.10	104.05	100.00	99.44
Total feed consumption (days 1-35)	kg/kg	1.743 ^A	1.886 ^C	1.824 ^B	1.820	1.815
S.D.	kg/kg	± 0.027	± 0.027	± 0.022	± 0.055	± 0.033
Index	%	100.00	108.20	104.65	100.00	99.73
Total feed consumption (days 1-42)	kg/kg	1.791 ^A	1.919 ^B	1.863 ^B	1.858	1.852
S.D.	kg/kg	± 0.026	± 0.037	± 0.020	± 0.054	± 0.024
Index	%	100.00	107.15	104.02	100.00	99.68

Capital letters designate highly significantly different values at $P < 0.01$

some nutritional conditions are observed. When RM is used as a SM replacement in starter and production mixtures for broilers, it is necessary to take into account the lower per cent concentrations of proteins and lower content of lysine. This finding has been reported by many researchers studying this problem. A 20% lysine premix was used in our trials: the amino acid ratio was adjusted by this application to the ratio of amino acids in soybean meal.

A significant difference in the content of metabolizable energy in both meals is an important problem related to SM replacement by RM. The use of lecithin slops, a waste product from the manufacture of cooking oils from rapeseed, is a way of eliminating this difference. It was reported in our previous paper (Prokop et al., 1997) that lecithin slops had negative effects on broiler performance when RM was applied in feed mixtures BR1 and BR2. But the results of this

VIII. The effect of two LS levels at a lower RM level and of enzymic concentrate AVC on broiler weight in Trial 3

Parameter	Unit	LS			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
Broiler number		80	80	80	120	120
Weight on day 1	g	50	50	50	50	50
Weight on day 21	g	584	567	596	579	586
S.D.	g	± 90	± 101	± 83	± 101	± 82
Index	%	100.00	97.09	102.05	100.00	101.21
Weight on day 35	g	1 360 ¹	1 368 ^{1,2}	1 434 ²	1 373	1 402
S.D.	g	± 217	± 205	± 191	± 220	± 191
Index	%	100.00	100.59	105.44	100.00	102.11
Weight on day 42	g	1 845	1 861	1 938	1 853	1 909
S.D.	g	± 256	± 271	± 269	± 290	± 241
Index	%	100.00	100.87	105.04	100.00	103.02

Legend for Tabs. VIII and IX:

a₀ - 0 g LS/100 kg feed

a₁ - 30 g LS/100 kg feed

a₂ - 60 g LS/100 kg feed

b₀ - 0 g AVC/100 kg feed

b₁ - 5 g AVC/100 kg feed

Arabic figures designate significantly different values at $P < 0.1$

IX. The effect of two LS levels at a lower RM level and of enzymic concentrate AVC on BR1 and BR2 mixture consumption (in kg) per 1 kg of weight gain in Trial 3

Parameter	Unit	LS			AVC	
		a ₀	a ₁	a ₂	b ₀	b ₁
BR1 mixture consumption (days 1-21)	kg	1.511	1.565	1.549	1.535	1.548
S.D.	kg	± 0.012	± 0.044	± 0.078	± 0.025	± 0.075
Index	%	100.00	103.57	102.51	100.00	100.85
BR2 mixture consumption (days 22-35)	kg	1.946 ^a	1.874 ^{ab}	1.832 ^b	1.900	1.869
S.D.	kg	± 0.053	± 0.064	± 0.043	± 0.087	± 0.049
Index	%	100.00	96.30	94.14	100.00	98.37
BR2 mixture consumption (days 22-42)	kg	2.018 ^A	1.973 ^{AB}	1.934 ^B	1.991 ¹	1.960 ²
S.D.	kg	± 0.060	± 0.047	± 0.031	± 0.070	± 0.039
Index	%	100.00	97.77	95.84	100.00	98.44
Total feed consumption (days 1-35)	kg	1.765 ¹	1.751 ^{1,2}	1.719 ²	1.750	1.739
S.D.	kg	± 0.027	± 0.035	± 0.043	± 0.046	± 0.033
Index	%	100.00	99.21	97.39	100.00	99.37
Total feed consumption (days 1-42)	kg	1.864	1.855	1.821	1.854	1.839
S.D.	kg	± 0.037	± 0.028	± 0.033	± 0.043	± 0.029
Index	%	100.00	99.52	97.69	100.00	99.19

Capital letters designate highly significantly different values at $P < 0.01$

Small letters designate significantly different values at $P < 0.05$

Arabic figures designate significantly different values at $P < 0.1$

study were different since LS had positive effects on growth parameters and on feed consumption per 1 kg of weight gain in Trial 3. LS analysis and comparison of their composition showed a large difference in acid number 62.7 mg KOH/g LS (Prokop et al., 1997) and acid number 31.6 mg KOH/g of lecithin slops used in Trials 1 and 3. The high acid number of lecithin slops used in trials conducted by Prokop et al. (1997)

indicates degradation processes occurring in the adipose component of LS that are likely to have had negative effects on broiler growth and feed consumption (in kg) per 1 kg of weight gain.

Our experimental data suggest the problem of LS quality used for RM energy fortification. Limitation of microbial processes inducing changes in the LS adipose component might be a solution to this problem. The

stability of lecithin slops in feed mixtures should be guaranteed for 4 to 6 months at least, i.e. for the guarantee period of broiler starters and production mixtures.

The effect of enzymic concentrate AVC, containing a complex of proteolytic enzymes, enzymes splitting nonstarch polysaccharides and lipases, was negligible after its application with RM. Positive effects of AVC were observed when feed mixtures were supplemented with LS.

REFERENCES

DAENICKE, S. – JEROCH, H. – KRACHT, W. – HEIDENREICH, E.: Effect of different technical treatment procedures of rapeseed on the nutrients digestibility and on the conversion of energy by broiler and laying hens. 106. VDLUFA Congr., Jena, 1994: 816–818.

HASČÍK, P. – KOVÁČ, M. – HANZLÍK, K.: Substitution of rape-seed oilcake for soybean meal in the second feeding phase of broilers. *Živoč. Vyr.*, 39, 1994: 1041–1047 (in Slovak).

KADLEC, J. – ČERMÁK, B. – LAD, F.: Verification of rape cakes containing the AMP 50 preparation in feed mixtures with lower content of nitrogen compounds in the fattening of

broiler chickens. Sbor. Jihočes. Univ., Zemědělská fakulta, České Budějovice, 1994 (2): 69–79 (in Czech).

LESSIRE, M. – EVRARD, J. – WIDIEZC, J. L. – QUIN-SAC, A. – FAÜDUET, H.: Prospects for use of rapeseed meal in broiler. In: Colloquium Glucosinolates, 10 Years of Research, Ardon, 14, 1993: 96–103.

PROKOP, V. – KUMPRECHT, I. – ZOBAC, P. – PÁROVÁ, J.: Rapeseed meal in broiler chick diets, [Final Report.] Pohofelice, RIAN 1997. 22 p. (in Czech).

SCHÖNE, F. – JAHREIS, G. – RICHTER, G. – LANGE, R.: Evaluation of rapeseed meals in broiler chicks: effect of iodine supply and glucosinolate degradation by myrosinase or copper. *J. Sci. Fd Agric.*, 61, 1993: 245–252.

SCHLÖFFEL, J. – JEROCH, H. – SEFFNER, W. – JAHREIS, G.: Toasted rapeseed meal in broilers fattening diet. *Arch. Anim. Nutr.*, 45, 1993: 79–87.

SNEDECOR, G. W. – COCHRAN, W. C.: Statistical Methods. 6th ed. Ames, The Iowa State Univ. 1969.

VÝMOLA, J. – KODEŠ, A. – OBADÁLEK, J.: Rapeseed cake in diets of broiler chicks. *Živoč. Vyr.*, 40, 1995: 407–409 (in Czech).

CSN 46 7092 Standard. Methods of Feed Testing. Praha, Office for Standardization and Measures 1985.

Received for publication on April 27, 1998

Accepted for publication on July 14, 1998

Contact Address:

RNDr. Petr Z o b a č, CSc., Výzkumný ústav výživy zvířat, s. r. o., 691 23 Pohofelice, Česká republika, tel.: 0626/42 45 41, fax: 0626/42 43 66

ÚSTAV ZEMĚDĚLSKÝCH A POTRAVINÁŘSKÝCH INFORMACÍ

Ústřední zemědělská a lesnická knihovna (ÚZLK)

Slezská 7, 120 56 Praha 2, tel.: 02/24 25 79 39, fax: 02/24 25 39 38

Máte zájem o pravidelné sledování nejčerstvějších informací ze zahraničních odborných časopisů?

Tento požadavek Vám rádi splníme, objednáte-li si naši informační reprografickou službu „Obsahy zahraničních časopisů“ a články typu „Current Contents“.

Vyberete-li si z každoročně aktualizovaného **Seznamu časopisů objednaných do fondu ÚZLK** sledování nejzajímavějších časopisů z Vašeho oboru, zašleme Vám nejprve kopie obsahů nejčerstvějších čísel časopisů a na základě výběru kopie požadovaných článků.

Chtěli bychom Vás také upozornit na další reprografickou službu ÚZLK, a to na poskytování kopií článků z knih a časopisů, které jsou ve fondu ÚZLK. Požadavky na tyto kopie můžete uplatňovat v průběhu celého roku na formulářích „Objednávka reprografické práce“, které si můžete objednat v Technickém ústředí knihoven, Solniční 12, 601 74 Brno, pod katalog. č. TÚK 138-0.

Veškeré další informace a objednávky na reprografické služby včetně Vašich připomínek Vám poskytneme na adrese:

Ústřední zemědělská a lesnická knihovna – ÚZPI

Odd. reproslužeb

Slezská 7, 120 56 Praha 2

Poštovní schránka 39

Telefonické dotazy: 02/24 25 79 39, linka 329, 421 nebo 306

PASSAGE TIME OF ARTEMIA NAUPLII THROUGH THE GUT OF TENCH (*TINCA TINCA* L.) LARVAE AT 22 °C

DOBA PRŮCHODU NAUPLIÍ ARTÉMIE STŘEVEM LÁREV LÍNA OBECNÉHO (*TINCA TINCA* L.) PŘI TEPLOTĚ 22 °C

M. Szlamińska¹, T. Węgleńska², J. Hamáčková³, J. Kouřil³, P. Kozák³, I. Adámková³

¹ International Center of Ecology, Polish Academy of Sciences, Dziekanów Leśny, Poland

² Institute of Ecology, Polish Academy of Sciences, Dziekanów Leśny, Poland

³ Research Institute of Fish Culture and Hydrobiology, University of South Bohemia, Vodňany, Czech Republic

ABSTRACT: The experiment was carried out on tench larvae aged 14 and 19 days. They were fed *Artemia* nauplii and the time of food passage through the larval gut was assessed. The time of fully emptying of gut of whole fish sample (no *Artemia* in the gut of 10 indiv.) reached 6 h and 7 h in the larvae aged 14 d and 19 d, respectively. In younger larvae 50% of initial gut filling was observed between 1 and 2 h of gut emptying, while in older ones between 2 and 3 h. The time required for total emptying of 5 individuals (50% of sample size) from the each age group was 2 h and 5 h, respectively.

tench; *Tinca tinca* L.; larvae; physiology; passage time through the gut; *Artemia* nauplii feeding

ABSTRAKT: Byl proveden experiment s larvami lína ve věku 14 a 19 dní. U larev krmených nauplii artémie byla stanovována doba průchodu potravy jejich střevem. Doba pro úplné vyprázdnění střeva u všech ryb ve vzorku (ve střevech 10 larev se nevyskytla žádná artémie) dosáhla 6 hodin pro larvy ve věku 14 dní a 7 hodin pro larvy ve věku 19 dní. U mladších larev byla pozorována 50% počáteční naplněnost střeva mezi první a druhou hodinou jeho vyprázdnění, zatímco u starších larev mezi druhou a třetí hodinou. Doba potřebná pro úplné vyprázdnění činila u 5 larev (50 % vzorku) v jednotlivých věkových skupinách 2 hodiny a 5 hodin.

lín; *Tinca tinca* L.; larva; fyziologie; doba průchodu střevem; krmení nauplii artémie

INTRODUCTION

For the years the tench was a neglected species in aquaculture research (Steffens, 1995). The First International Workshop on the species was held in the Czech Republic in 1994. The participants in the Workshop underlined the need of development of our knowledge, among others of tench physiology (Flajšhans, Billard, 1995).

The tench is characterized by a small mouth gape, thus it needs small food preys. Feeding of tench larvae with small size zooplankton from the beginning of exogenous feeding is a routine in Czech aquaculture (Hamáčková et al., 1995). Moreover the trials with dry food feeding of tench larvae were carried out in Poland (Wolnicki, Korwin-Kossakowski, 1993).

The crucial problem in fish rearing is the amount of food given to larvae and frequency of feeding. One of the elements of daily food ration is the time required for food to pass through the fish gut (Szlamińska et al., 1995).

The aim of the present experiment was an assessment of *Artemia* nauplii passage time through the gut of two age groups of tench larvae.

MATERIAL AND METHODS

The experiment on gut passage time in tench larvae fed *Artemia* nauplii was performed in the Research Institute of Fish Culture and Hydrobiology, University of South Bohemia at Vodňany in 1996. Larvae were aged 14 and 19 days. At the beginning of the test they were fed in excess during two hours. After this time the 0 sample for fullness of gut was taken. Subsequently, larvae were separated from *Artemia* and a sample of 10 larvae was taken every hour for assessment of the number of nauplii in the digestive tract. Experiments were carried out at 22 °C.

After 6 months of storage in 4% formaldehyde larvae were measured and their alimentary tracts were dissected to count *Artemia* in the gut of each larvae.

RESULTS

Mean body length of larvae aged 14 d was 7.31 ± 0.66 mm and total length was 7.66 ± 0.59 mm. The larvae aged 19 d had body length of 8.21 ± 0.54 mm and total length of 8.99 ± 0.63 mm.

The passage time of *Artemia* nauplii through the gut was 6 h in younger larvae and 7 h in older ones (Fig. 1). From the third h of gut emptying the younger larvae had less than one *Artemia* in the gut on average (Tab. I). Younger larvae ate less preys than older ones (Tabs. I and II), i.e. calorific equivalent of preys in the gut was higher than in younger ones. In younger larvae 50% of initial gut filling was observed between 1 and 2 h of gut emptying (Tab. I), thus in older ones between 2 and 3 h (Tab. II). In the larvae aged 14 d more than 5 individuals in the sample (50% of sample size) had empty gut 2 h after cessation of feeding, while in larvae aged 19 d the time required for emptying 50% of the larval guts was 5 h.

DISCUSSION

Food intake in excess is characteristic of cyprinid fish larvae. Larvae fill their alimentary tracts to the anatomical barrier. In this case the newly caught preys push the intestinal content through the gut and accelerate the defecation. Van der Meer (personal communication) observed living *Artemia* coming from the anus of halibut overfed larva. Under the conditions of food excess, the passage time is short. This phenomenon was observed by Hofer, Nassir Uddin (1985) in roach larvae in the first days of their life. Passage time in their experiment was short, increased from 2 h (larvae weighing 3 mg) to 5 h (juveniles weighing 1 g). Thus the "pusher effect" in their experiment was evident. In the present experiments the "pusher effect" did not manifest itself. The passage time was long and the intestinal content might be well digested. Similarly, Szlamínska (1987) noted this phenomenon in carp larvae fed dry feed. In her experi-

I. *Artemia* nauplii passage through the gut of tench larvae aged 14 days

Time	\bar{x}	SD	Ww*	Dw*	C*	E.G.
0	11.3	3.68	0.226	0.0226	0.339	0
1	5.8	3.85	0.116	0.0116	0.174	10
2	1.8	3.65	0.036	0.0036	0.054	40
3	0.9	1.91	0.018	0.0018	0.027	70
4	0.2	0.42	0.004	0.0004	0.006	80
5	0.1	0.32	0.002	0.0002	0.003	90
6	0	0	0	0	0	100

* recalculated according to Osse, Drost (1989)

For Tabs. I and II: Time – time of gut emptying (h), \bar{x} – mean number of nauplii in the gut (indiv.), SD – standard deviation, Ww – wet weight (mg), Dw – dry weight (mg), C – calorific equivalent (J), E.G. – number of empty guts in the sample (%)

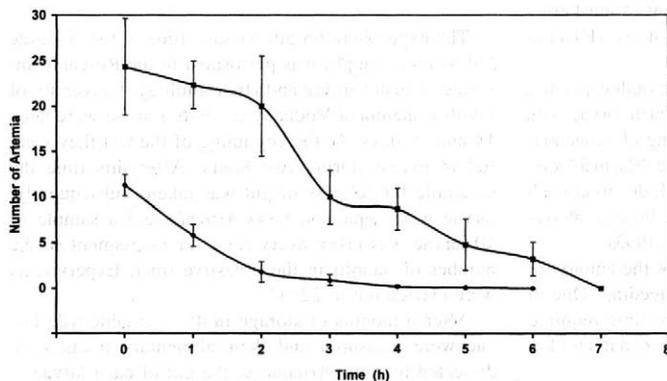
II *Artemia* nauplii passage through the gut of tench larvae aged 19 days

Time	\bar{x}	SD	Ww	Dw	C	E.G.
0	24.3	16.86	0.486	0.0486	0.729	0
1	22.3	8.27	0.446	0.0446	0.669	0
2	20.0	17.38	0.400	0.0400	0.600	10
3	10.0	9.26	0.200	0.0200	0.300	20
4	8.7	7.20	0.174	0.0174	0.261	10
5	4.8	8.94	0.096	0.0096	0.144	70
6	3.2	5.90	0.064	0.0064	0.096	70
7	0	0	0	0	0	100

ments the evacuation of one kind of dry food from the gut of larvae after the cessation of feeding was longer than 10 h.

Hofer and Nassir Uddin (1985) showed the increase of passage time with larval age. In the present experiments passage times were shorter in younger, less developed larvae than in older ones.

Yazhombek (1986) assessed that the time required for *Artemia* nauplii to pass through the gut of common carp larvae weighing 2 mg was 7 h at 25 °C. On the other hand, Eldrige et al. (1982) observed



1. *Artemia* nauplii passage through the gut of larvae; diamonds – larvae aged 14 days, squares – larvae aged 19 days, bars – standard errors of the means

gut evacuation of *Morone saxatilis* larvae weighing 0.2–20 mg at 18 °C and found that the passage time varied from 2.3 to 4.5 h. Thus the passage time in *Morone saxatilis* was shorter than in common carp larvae. Present results lie between the data of the above-mentioned authors. The specificity of that phenomenon in tench larvae, when compared with other fish species, was not evidenced.

REFERENCES

ELDRIGE, M. B. – WHIPPLE, J. A. – BOWERS, M. J.: Bioenergetics and growth of striped bass *Morone saxatilis* embryos and larvae. *Fishery Bull.*, 80, 1982: 461–474.

FLAJŠHANS, M. – BILLARD, R.: In: Proc. Int. Workshop on the Biology and Culture of the Tench (*Tinca tinca* L.) held in Ohrada Hunting Lodge by Hluboká nad Vltavou, Czech Republic, August 28–September 1, 1994. Preface. *Pol. Arch. Hydrobiol.*, 42, 1995: 5–6.

HAMÁČKOVÁ, J. – KOUŘIL, J. – KAMLER, E. – SZLAMINIŃSKA, M. – VACHTA, R. – STIBRANYIOVÁ, I. – MUŃOZ ASENJO, C.: Influence of short-term temperature decreases on survival, growth and metabolism of tench (*Tinca tinca* L.) larvae. *Pol. Arch. Hydrobiol.*, 42, 1995: 109–120.

HOFER, R. – NASSIR UDDIN, A.: Digestive processes during the development of the roach, *Rutilus rutilus* L. *J. Fish. Biol.*, 26, 1985: 683–689.

OSSE, J. W. M. – DROST, M. R.: Hydrodynamics and mechanics of fish larvae. *Pol. Arch. Hydrobiol.*, 36, 1989: 455–465.

STEFFENS, W.: The tench (*Tinca tinca* L.) a neglected pond fish species. *Pol. Arch. Hydrobiol.*, 42, 1995: 161–180.

SZLAMINIŃSKA, M.: Intestine evacuation rate in cyprinid larvae fed two kinds of dry feeds at 24 °C. *Acta Ichthyol. et Piscatoria*, 17, 1987: 35–41.

SZLAMINIŃSKA, M. – KWAŃNY, M. – HAMÁČKOVÁ, J. – KOUŘIL, J. – VACHTA, R. – STIBRANYIOVÁ, I.: Passage time and consumption of catfish (*Silurus glanis* L.) larvae fed formulated diet. In: LAVENS, P. – JASPERS, E. – ROELANTS I. (eds.): Larvi'95 – Fish and Shellfish Larviculture Symp. Europ. Aquacult. Soc. Spec. Public., 24, 1995: 305–307.

WOLNICKI, J. – KORWIN-KOSSAKOWSKI, M.: Survival and growth of larval and juvenile tench, *Tinca tinca* L., fed different diets under controlled conditions. *Aquacult. Fish. Manage.*, 24, 1993: 707–713.

YAZHOMBEK, A. A. (ed.): *Fish Physiology Tables*. Moscow, Agropromizdat 1986 (in Russian).

Received for publication on May 19, 1998

Accepted for publication on July 14, 1998

Contact Address:

Dr Małgorzata Szlaminińska, International Center of Ecology, Polish Academy of Sciences, Dziekanów Leśny, PL-05-092 Lomianki, Poland, tel.: +48/22/751 30 46, fax: + 48/22/751 31 00

INSTITUTE OF AGRICULTURAL AND FOOD INFORMATION

Slezská 7, 120 56 Praha 2, Czech Republic

Fax: (00422) 24 25 39 38

In this institute scientific journals dealing with the problems of agriculture and related sciences are published on behalf of the Czech Academy of Agricultural Sciences. The periodicals are published in the Czech or Slovak languages with long summaries in English or in English language with summaries in Czech or Slovak.

Subscription to these journals should be sent to the above-mentioned address.

Periodical	Number of issues per year
Rostlinná výroba (Plant Production)	12
Czech Journal of Animal Science (Živočišná výroba)	12
Veterinární medicína (Veterinary Medicine – Czech)	12
Zemědělská ekonomika (Agricultural Economics)	12
Lesnictví – Forestry	12
Zemědělská technika (Agricultural Engineering)	4
Plant Protection Science (Ochrana rostlin)	4
Czech Journal of Genetics and Plant Breeding (Genetika a šlechtění)	4
Zahradnictví (Horticultural Science)	4
Czech Journal of Food Sciences (Potravinařské vědy)	6

EFFECT OF PROBIOTIC-ENZYMATIC ADDITIVE WITH GLUCOSE OXIDASE ON FERMENTATION OF FORAGES ENSILED UNDER LOW CONTENT OF DRY MATTER*

VLIV PROBIOTICKO-ENZYMATICKÉHO ADITIVA S GLUKÓZAOXIDÁZOU NA FERMENTACI PÍCNIN SILÁŽOVANÝCH PŘI NÍZKÉM OBSAHU SUŠINY

R. Loučka¹, E. Machačová¹, P. Homolka¹, J. Moravcová², M. Čerovský², M. Voldřich²

¹Research Institute of Animal Production, Praha-Uhřetěves, Czech Republic

²Institute of Chemical Technology, Praha, Czech Republic

ABSTRACT: The grass of the Bečva variety, the clover of the Kvarťa variety and their mixture with average representation of 54% of grass and 46% of clover were ensiled under a very low content of the original dry matter content between 19.5 and 22.0% into the laboratory silos of the volume 0.1 m³, the control was without an additive and the experimental ones were with the probiotic-enzymatic additive Bactozym (Medipharm CZ, s.r.o., Hustopeče u Brna). As unfavourable effect of very low content of dry matter of forages on their fermentation could not be suppressed by an additive, it is not recommended to ensile grass, clover and clover-grass stands under the content of dry matter lower than 22%, not even with the use of the probiotic-enzymatic additive Bactozym.

silage; grass; clover; additive; glucose oxidase

ABSTRAKT: Tráva odrůdy Bečva, jetel odrůdy Kvarťa a jejich směs s průměrným zastoupením 54 % trávy a 46 % jetele byly silážovány při velmi nízkém obsahu původní sušiny (19,5–22,0 %) do laboratorních sil o objemu 0,1 m³, kontrolně bez aditiva a pokusně s probioticko-enzymatickým aditivem Bactozym (Medipharm CZ, s. r. o., Hustopeče u Brna). Řezanka byla ukládána do speciálních laboratorních sil (umělohmotných tubusů) o objemu 10 litrů. Bylo naplněno 36 sil, šest variant v šesti opakováních. Do laboratorních sil se řezanka dusala speciálním pneumatickým dusačem PS-01 tlakem 0,5 MPa. Hmotnost v každém síle byla zatížena olověným závažím o hmotnosti 10 kg a pak vzduchotěsně uzavřena. Odběry vzorků, chemické analýzy a hodnocení siláží byly prováděny podle ČSN 46 7092. Pro stanovení aerobní stability byly siláže ihned po otevření sil nasypany do speciálních nádob o objemu 1 litr, které pak byly uloženy do polystyrenových boxů. Do každého vzorku siláže v boxu bylo vnořeno teplotní čidlo napojené na automatické zařízení APO Elmos H32. V místnosti s boxy byla udržována teplota 25 °C. U travních siláží přídavek aditiva oproti kontrole bez aditiva významně ($P < 0,05$) snížil hodnoty pH (na 4,45 z 4,68), zvýšil obsah kyseliny mléčné (na 1,82 z 1,64 %) a snížil počty plísní (na 1,78 z 3,27 log CFU/g). U jetelotravních siláží byl zjištěn pozitivní vliv aditiva pouze ve snížení pH (na 4,4 z 4,49), u jetelových siláží ve snížení obsahu kyseliny octové (na 1,12 z 1,31 %). Ihned po otevření sil byly provedeny mikrobiální testy. U travních siláží s aditivem byly zjištěny významně ($P < 0,05$) nižší počty plísní než v silážích travních bez aditiva. Siláže s aditivem měly nižší aerobní stabilitu než siláže bez aditiva, siláže travní měly nižší aerobní stabilitu než siláže jetelové. Protože nepříznivý vliv velmi nízkého obsahu sušiny píce na jejich fermentaci aditivum nedokázalo plně potlačit, nedoporučujeme travní, jetelové ani jetelotravní porosty silážovat při obsahu sušiny nižším než 22 %, a to ani s použitím probioticko-enzymatického aditiva Bactozym.

siláže; tráva; jetel; aditiva; glukózaoxidáza

INTRODUCTION

According to Chamberlain et al. (1992) the protein forage cannot be ensiled with success under the content of dry matter 20% and less, not even when

chemical or biological additives are applied. Sormunen and Mannerkorpí (1994) recommend to ensile such a forage only with the use of absorbents.

Under the content of dry matter of 20, 30 and 40% Van Vuuren et al. (1989) ensiled the second cut of

* The research was financed by the Grant Agency of CR, reg. number 507/94/1257, and under the support of the Ministry of Agriculture of CR.

grass-clover mix (with 83% representation of ryegrass into 1.5 litre bottles. Each variant was ensiled at three different phases of vegetation maturity, without additives and with the enzymatic additive Clampzyme (CZ). The best results were obtained in the silage from the youngest stand, of the dry matter of 30%, preserved with CZ. The effect of additive with CZ was higher in the younger stand than older one and in moister than drier material. The digestibility of organic matter with increasing vegetation season was decreasing, the content of ADF and NDF in dry matter was increasing. The silages with the lowest content of the dry matter had the highest digestibility of organic matter. The fermentation process was evaluated as the worst of all variants in the silages of forages harvested later and preserved at the dry matter of 40%.

Parameters of the quality of the fermentation process in grasses when combined probiotic-enzymatic preparations were applied were compared in many publications, e.g. Huhtanen et al. (1985), Rauramaa et al. (1987), Jambor et al. (1989) and Bolsen (1993). The task of hydrolytic enzymes in probiotic-enzymatic additives consists mainly in the deterioration of structural polysaccharides of cell walls into simpler sugars which should be a broth for homo-fermentative lactic bacteria (Kennedy, 1987; Jacobs, McAllan, 1991; Stokes, Dhar, 1991; Vanhatalo et al., 1992). Oxidoreduction enzyme - glucose oxidase (GO) has in an additive a task to convert glucose with the use of water and oxygen into gluconic acid and hydrogen peroxide, GO should have a significant effect on the decrease of pH of the silages (Heikonen et al., 1984; Jacobs, McAllan, 1991; Jacobs et al., 1991; Rauramaa et al., 1991). Inoculation with bacteria of lactic fermentation mostly increases the efficiency of fermentation and improves digestibility of fibre (Merry, McAllan, 1989; Pahlow, Honig, 1989; Stokes, 1992).

MATERIAL AND METHODS

This study was aimed at the characterization of the effect of probiotic-enzymatic additive on the result of fermentation of forages ensiled under a very low content of dry matter.

The trial included the following forages:

- 1) The grass of the Bečva variety (*Lolium multiflorum* L. x *Festuca arundinacea* Schreb., $2n = 28$) arose by the crossing of Italian ryegrass (Rožnovský and Tira) with ecotypes of tall fescue from Hladké Životic and by reverse crossing of F_1 hybrids with tetraploid Italian ryegrass Lolita. Bečva is the variety of ryegrass type, certified since 1989. With respect to high content of water-soluble sugars it is suitable to be preserved by ensilage.
- 2) Red clover of the Kvarťa variety (*Trifolium pratense* L., $2n = 28$), medium-early, efficient variety for two crop years, two cut, with a wide distribution in the

CR and neighbouring countries of the Central Europe. It is ageing slowly, therefore it has a longer period of utilization.

- 3) The grass mix Bečva and clover mix Kvarťa cultivated directly in the field (it was not formed by mere mixture of two substrates), during the harvest with weight ratio between grass and clover 54.1% of grass and 45.9% of clover.

Experimental forage crops were cultivated in one field (in the plots of 0.5 hectares of size with placing abreast), treated by the same way and on the same dates, also ways and procedures during the harvest and wilting of the forage in the field were identical. The second cut was ensiled on June 21. Soon after cutting of the stands by the masher (E-301) started rainy weather which should persist according to the weather reports longer than a week. The forage was on the fourth day after cutting, at the average dry matter content of 21%, raked into rows and immediately harvested by the chaff-cutter Jaguar Class with an adjusted theoretical length of the chaffed parts of 15 mm.

Forage crops were ensiled as the controls without an additive and experimentally with the probiotic-enzymatic additive of the trade name Bactozym (manufactured by Medipharm CZ, s.r.o., Hustopeče u Brna). Its enzymatic component is formed by the complex of cellulase and hemicellulase (25,000 nkat/ml) with glucose oxidase (4.00 nkat/ml), bacterial component consists of the strains of lactic bacteria (*Lactobacillus plantarum*, *Lactobacillus casei*, *Enterococcus faecium*, *Pediococcus acidilactici* in the total concentration of 10.18 log CFU/g of loose preparation, energy component (carrier) is the dried instant milk and saccharose. An additive was dosed by the spray applicator directly on the chaff-cutter at the amount of 10 g bacterial, 100 ml of enzymatic component and 400 ml of water per 1 ton of the forage. In the variant without an additive as much water was added per unit of the ensiled matter it was added as it was used for dilution of components in the variant with additive.

The chaff was filled into the special laboratory silos (plastic tubes) of the volume 10 litres. 36 silos were filled, six variants in six replications. The chaff tamped was in the special pneumatic stamper PS-01 under the pressure of 0.5 MPa. The mass in the silo was loaded with lead weight weighing 10 kg and then air-tight closed. The sensor of automatic equipment APO Elmos H32 for continuous measurement and recording of temperatures was placed in the middle part of each silo (equipment has 36 temperature sensors, measurement was carried out in regular 6 hour intervals). Laboratory silos were isolated by four layers of insulating fabric and placed in the laboratory of the Research Institute of Animal Production Uhřetíněves at the stable temperature of 25 °C.

Taking of samples, chemical analyses and evaluation of the silages were performed according to the standard ČSN 46 7092 (1996). To determine the aerobic stability silages were immediately after opening of

silos poured into special vessels of 1 litre volume, these were placed then in polystyrene boxes. The temperature sensor was dipped into each sample of the silage in the box and this was connected with automatic equipment APO Elmos H32. The temperature of 25 °C was kept in the room with boxes. The aerobic stability was evaluated on the basis of the interval measurement of temperatures (seven days each six hours), according to the growth of the number of microorganisms on the second and seventh day after opening of the silos and parameters which were published by Honig (1986), Ashbell et al. (1991) and Kacerovská, Kacerovský (1993). The methods of taking of samples for microbiological analyses and the method of microbiological testation are described in more detail in the study of Čeřovský et al. (1997). Mesophilic bacteria were cultivated on the meat-peptone agar, coliformic bacteria on End's agar, moulds on Czapek-Dox's agar with raised selectivity (250 mg of chloramphenicol/500 ml of water and 150 mg of the Bengal red/1,000 ml of water). Chloramphenicol (250 mg/500 ml) was added into sweet wort agar to suppress the growth of bacteria and increase of selectivity.

RESULTS AND DISCUSSION

The grass was at the time of harvest in the first phase of earing, clover was in the phase of bud setting, that is in the optimum time of maturity. In the time of harvest the dry matter of the grass was 22.0%, the dry matter of grass-clover was 20.5% and the content of clover dry matter was 19.5%, concentration of crude protein was 122 in grass, in clover 203 g/kg of dry matter, concentration of fibre in grass 278, in clover 174 g/kg of dry matter. From the point of view of the content of dry matter in all cases the ensiled material was hard to be ensiled. According to Jakobe et al. (1987) at this content of dry matter pH values should not be higher in silages than 4.2. The values of the glucose and fructose content in the Bečva variety (Tab. I) correspond to the data published by Fojtík (1994). The Bečva variety was chosen on the basis of previous investigations of various varieties according to the suitability for ensilage (Loučka, 1995). According to Fojtík et al. (1990) the Bečva variety is one of the most suitable grasses for preservation by ensilage. Kuncl and Turek also ranks in the evaluation of the grasses according to ensilage capacity the Bečva variety on the first place. Merry et al. (1996), Thorsteinsson et al. (1996), Valente et al. (1996) and Moravcová et al. (1997b) were

dealt with the effect of the content of saccharides in the forage on its ensilage capacity. There are great differences between results of different authors given by the method of determination of saccharides. Moravcová et al. (1997a) recommend their determination in plants by the method of liquid chromatography on strongly acidic ion exchanger.

During fermentation in no variant the temperature inside the ensiled matter did not increase above the original temperature of the medium 25 °C.

There were no differences between the tested silages, however they were significantly different ($P < 0.05$) in the concentration of crude proteins and PDI in dry matter (in grass-clover silages higher values than in grass silages), fibre (in clover silages lower values than in grass and grass-clover silages) and energy in NEL units (lower values in clover silages than in grass silages). The effect of additive on parameters of nutritive values was not significant (Tab. II).

The difficult ensilage capacity of all tested forages at such a low content of dry matter is documented by the fact that neither grass silage with additive, evaluated in view of fermentation as the best variant, had not the content of lactic acid higher than 1.82% and ratio of its content to the content of volatile fatty acids in the silage was not higher than 1.5 : 1. pH values of all silages ranged above the limit of critical minimum which is 4.2 for 20% dry matter.

The effect of additive was significant ($P < 0.05$) only in some parameters of fermentation of the tested forage crops. In grass silages with the applied additive in contrary to the control without additive were significantly ($P < 0.05$) reduced pH values and increased the content of lactic acid (Tab. II). The positive effect of additive was found in grass-clover silages only in decrease of pH, in clover silages in decrease of the content of acetic acid. Grass silages had significantly lower content of butyric acid than grass-clover and clover silages.

Immediately after opening of the silos microbial tests were carried out (Figs. 1–3). Significantly lower numbers of moulds were recorded in grass silages with an additive than in grass silages without it. Not only higher numbers of mesophilic bacteria, yeasts and moulds were found in clover silages with additive compared with clover silages without additive, but also of coliformic bacteria (3.2 log CFU/g) what indicates the contamination of the sample by soil or dust. No significant differences ($P > 0.05$) were recorded in the numbers of microorganisms between grass-clover silages with additives and without them.

After evaluation of all parameters of the quality of the fermentation process of the tested silages it can be

I. Contents of saccharides in original material

Type of sugar	Units	Grass silages	Grass-clover silages	Clover silages
Fructose	g/kg DM	59.0	38.5	29.5
Glucose	g/kg DM	50.3	32.3	17.6

II. The quality of grass, grass-clover and clover silages

Parameter	Units	Grass silages		Grass-clover silages		Clover silages	
		N	A	N	A	N	A
Dry matter	g/kg	198a	203a	184a	191a	201a	201a
Crude protein	g/kg DM	14.8a	14.6a	17.3ab	17.0ab	18.2b	19.2b
Fibre	g/kg DM	31.3 ^a	30.6 ^a	31.8 ^a	30.9 ^a	22.5 ^b	23.6 ^b
NEL	MJ/kg DM	5.5 ^a	5.6 ^a	5.0 ^{ab}	5.1 ^{ab}	4.4 ^b	4.6 ^b
PDI	g/kg DM	7.4 ^b	7.5 ^b	8.0 ^a	8.1 ^a	8.1 ^a	8.4 ^a
pH value		4.68 ^a	4.45 ^b	4.49 ^b	4.40 ^c	4.48 ^b	4.53 ^b
Lactic acid	%	1.64 ^a	1.82 ^b	1.42 ^c	1.43 ^c	1.38 ^c	1.48 ^c
Acetic acid	%	1.04 ^a	1.03 ^a	1.13 ^b	1.05 ^a	1.31 ^c	1.12 ^b
Butyric acid	%	0.08 ^a	0.09 ^a	0.44 ^b	0.37 ^b	0.53 ^b	0.44 ^b
Bacteria:							
Mesophilic	log CFU/g	4.96 ^a	4.83 ^a	5.57 ^{ab}	5.52 ^{ab}	4.56 ^a	6.35 ^b
Coliformic	log CFU/g	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	3.20 ^b
Yeasts	log CFU/g	2.88 ^a	2.08 ^a	2.15 ^a	2.00 ^a	3.90 ^a	5.01 ^b
Moulds	log CFU/g	3.27 ^a	1.78 ^b	2.56 ^{ab}	1.78 ^b	3.23 ^a	5.33 ^c

Differences between values denoted by the letters (a, b, c) in the line are statistically significant ($P < 0.05$)

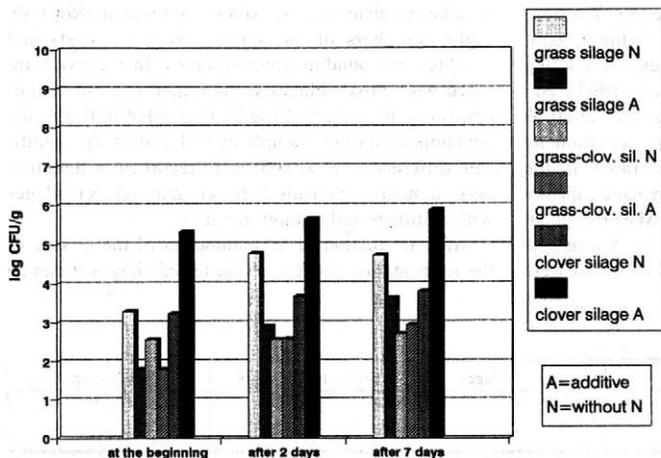
A = additive, N = without additive, NEL = netto energy of lactation, PDI = protein digestible intake, CFU = colony forming unit

said that the positive effect of probiotic-enzymatic additive on the resulting quality of the tested silages with a low content of dry matter was statistically significant ($P < 0.05$) in some parameters. Similar conclusions were drawn also by Stokes (1987), Jacobs, McAllan (1991), Jacobs et al. (1991) and Chen et al. (1994). Not even probiotic-enzymatic additive Bactozym could not fully suppress unfavourable effect of a very low content of dry matter of ensiled forage crops. This result is corresponding with the knowledge reported by e.g. Chamberlain et al. (1992), Amrane, Doreau (1993) and Harrison et al. (1994).

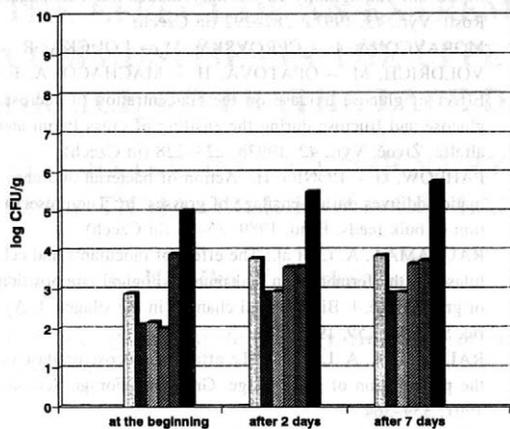
Silages with an additive had lower aerobic stability than the control silages. It can be concluded according to the earlier beginning of increase of temperatures

(Honig, 1986), higher top temperatures, higher production of CO₂ (Ashbell et al., 1991), higher enzymatic activity of catalase (Kacarovská, Kacarovský, 1993), high pH value, lower content of lactic acid and volatile acids, higher activity of mesophilic bacteria, yeasts and moulds (Figs. 1-3). Similar conclusions were made also by Chen et al. (1994). The most authors state that decreased aerobic activity is not a parameter of worse quality of the silage. The losses of aerobic degradation can be efficiently prevented by adjustment of the technology of taking out silages from silage space and by correct handling with silages before their administration.

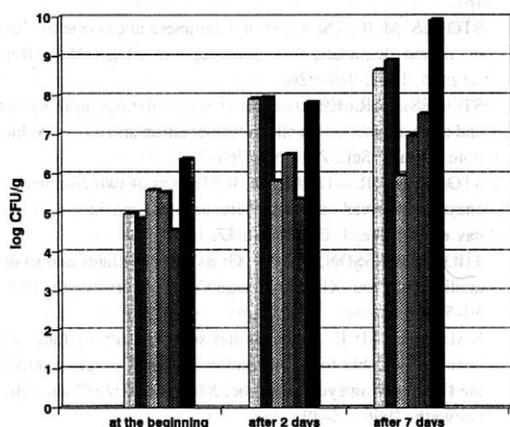
Aerobic stability of silages after two and in total seven days of action of air oxygen was evaluated the



1. Aerobic stability of silages – moulds



2. Aerobic stability of silages – yeasts



3. Aerobic stability of silages – mesophilic bacteria

best in clover silages, the worst in grass ones. Higher susceptibility of silages with better ensilage capacity to aerobic degradation is, according to **Bolsen** (1993), caused by higher content of residual sugars, which are a suitable substrate for microorganisms. **Victor and Rees** (1982) also call attention to the fact that aerobic losses are caused above all by the growth of microbial population which is significantly dependent on availability of microbial population to utilizable nutrients and air with oxygen and also on the temperature of environment. The losses from aerobic degradation in grass silages can reach as much as 10% as the above authors reported.

REFERENCES

AMRANE, R. – DOREAU, B. M.: Effect of maturity stage of Italian ryegrass and lucerne on ruminal nitrogen degradability. *Ann. Zootechn.*, 42, 1993: 31–37.

ASHBELL, G. et al.: A simple system to study the aerobic determination of silages. *Can. Agric. Eng.*, 33, 1991: 391–393.

BOLSEN, K. K.: The effect of inoculants and enzymatic preparations on the fermentation process and quality of silages. In: *VIIth Int. Symp. on Preservation of Bulk Feeds*, Pohořelice, 1993: 51–58 (in Czech).

CHAMBERLAIN, D. G. et al.: Effects of the type of additive and the type of supplement on the utilization of grass for milk production in dairy cows. *Grass and Forage Sci.*, 47, 1992: 391–399.

CHEN, J. et al.: Effects of enzyme-inoculant systems on preservation and nutritive value of haycrop and corn silages. *J. Dairy Sci.*, 77, 1994: 501–512.

ČEŘOVSKÝ, M. – LOUČKA, R. – MACHAČOVÁ, E. – VOLDŘICH, M. – OPATOVÁ, H. – MORAVCOVÁ, J.: The effect of probiotic-enzymatic additives on the ensiling of wilted grass (*Lolium multiflorum* Lam. x *Festuca pratensis* Huds.) and alfalfa (*Medicago sativa* L.). *Živoč. Vyr.*, 42, 1997: 323–329 (in Czech).

- FOJTÍK, A.: Notes on the utilization of selected grass and clover varieties. In: Production, harvest and preservation of bulk feeds from perennial forage crops, 1994: 13–28 (in Czech).
- FOJTÍK, A. et al.: New varieties of festulolium, *Festuca arundinacea* and *Poa pratensis*. In: Proc. 13th General Meeting of the European Grassland Federation, Soil-Grassland-Animal Relationships, Banská Bystrica, 1990: 459–461.
- HARRISON, J. H. et al.: Fermentation and utilization of silage. *J. Dairy Sci.*, 77, 1994: 3209–3235.
- HEIKONEN, M. et al.: A method for the preservation of fresh grass or cereals. Patent 66282 (WO 8401.644), Finland, 1984.
- HONIG, H.: Determination of aerobic deterioration – system Völkrode. Postanschrift, Bundesalleen 50, Braunschweig, 1985: 1–5.
- HUHTANEN, P. et al.: Enzymes as silage additive. Effect on fermentation quality, digestibility in sheep, degradability in sacco performance in growing cattle. *J. Agric. Sci. Finl.*, 57, 1985: 285–291.
- JACOBS, J. L. – McALLAN, A. B.: Enzymes as silage additives. 1. Silage quality, digestion, digestibility and performance in growing cattle. *Grass Forage Sci.*, 46, 1991: 63–73.
- JACOBS, J. L. – COOK, J. E. – McALLAN, A. B.: Enzymes as silage additives. 2. The effect of grass dry matter content on silage quality and performance in sheep. *Grass Forage Sci.*, 46, 1991: 191–199.
- JAKOBE, P. et al.: The preservation of feeds. Praha, SZN 1987. 262 p. (in Czech).
- JAMBOR, V. et al.: The effect of biological preparations during ensilage of protein and carbohydrate forage. In: The preservation of bulk feeds. Brno, 1989: 117–123 (in Czech).
- KACEROVSKÁ, L. – KACEROVSKÝ, O.: Assessment of the quality of ensiled feeds by enzymatic test. *Sbor. VŠZ Praha, R. B.*, 55, 1993: 261–269 (in Czech).
- KENNEDY, S. J.: The effect of an enzyme additive on the preservation and nutritive value of grass silage fed to beef cattle. In: Proc. VIIIth Silage Conf. Inst. Grassl. Anim. Prod. Hurley, Maidehead, England, 1987: 25–26.
- KUNCL, L. – TUREK, F.: Feeding and technological quality of distant grass hybrids. *Náš Chov (Praha)*, 1992 (5): 227–229 (in Czech).
- LOUČKA, R. – MACHAČOVÁ, E.: Effects of vegetation phase of three varieties of grass on digestibility, nutritive value and palatability of hay. *Ann. Zootechn.*, 44, 1995: 198.
- MERRY, R. J. – McALLAN, A. B.: Biological additives for forage preservation. In: The preservation of bulk feeds, Brno, 1989: 70–84 (in Czech).
- MERRY, R. J. et al.: Degradation of fructans during ensilage of grass with inoculants. In: Proc. XIth Intern. Silage Conf., Aberystwyth, 1996: 110–111.
- MORAVCOVÁ, J. – STANĚK, J. – ČAPKOVÁ, J. – LOUČKA, R.: Determination of saccharose, glucose in plants by liquid chromatography in strongly acidic ion exchanger. *Rostl. Výr.*, 43, 1997a: 287–292 (in Czech).
- MORAVCOVÁ, J. – ČEŘOVSKÝ, M. – LOUČKA, R. – VOLDŘICH, M. – OPATOVÁ, H. – MACHAČOVÁ, E.: Effect of glucose oxidase on the concentration of sucrose, glucose and fructose during the ensiling of grass Perun and alfalfa. *Živoč. Výr.*, 42, 1997b: 223–228 (in Czech).
- PAHLOW, G. – HONIG, H.: Action of bacterial and enzymatic additives during ensilage of grasses. In: The preservation of bulk feeds, Brno, 1989: 85–96 (in Czech).
- RAURAMAA, A. L. et al.: The effect of inoculants and cellulase on the fermentation and microbiological composition of grass silage. I. Biochemical changes in the silages. *J. Agric. Sci. Finl.*, 59, 1987: 361.
- RAURAMAA, A. L. et al.: The effect of glucose oxidase on the preservation of grass silage. *Grass and Forage Sci.*, 46, 1991: 359–364.
- SORMUNEN, C. R. – MANNERKORPI, P.: Feeding value of grass ensiled with absorbents as assessed by the use of growing lambs. In: Proc. 45th EAAP, Edinburgh, UK, 1994: 162.
- STOKES, M. R.: The effect of a commercial enzyme mixture on rumen degradation of grass-legume silage. *Nutr. Rep. Int.*, 36, 1987: 919–926.
- STOKES, M. R.: Effects of an enzyme mixture, an inoculant and their interaction on silage fermentation and dairy production. *J. Dairy Sci.*, 75, 1992: 764–773.
- STOKES, M. R. – DHAR, M. K.: Effects of two commercial enzyme additives on the preservation and nutritive value of hay crop silage. *J. Dairy Sci.*, 77, 1991: 314.
- THORSTEINSSON, B. et al.: Grass carbohydrates and silage quality. In: Proc. XIth Int. Silage Conf., Aberystwyth, 1996: 50–51.
- VALENTE, M. E. et al.: Water-soluble carbohydrate and hexoses available for fermentation in Italian regrass during the first growing cycle. In: Proc. XIth Int. Silage Conf., Aberystwyth, 1996: 48–49.
- VANHATALO, A. et al.: The effect of type of additive on rumen fermentation and digestion of grass silage in cattle. *J. Agric. Sci. Finl.*, 1992: 163–175.
- VAN VUUREN, A. M. et al.: Effects of addition of cell wall degrading enzymes on the chemical composition and the *in sacco* degradation of grass silage. *Grass and Forage Sci.*, 44, 1989: 223–230.
- VICTOR, D. – REES, H.: The aerobic deterioration of grass silage and its effect on the water-soluble carbohydrate and the associated heat production. *J. Sci. Food Agric.*, 33, 1982: 499–508.
- ČSN 46 7092 Standard. Methods of feed testing. Praha, 1996.

Received for publication on February 6, 1998

Accepted for publication on July 14, 1998

Contact Address:

Ing. Rádko Loučka, CSc., Výzkumný ústav živočišné výroby, 104 00 Praha 10-Uhřetěves, Česká republika, tel.: 02/67 71 17 47, fax: 02/67 71 14 48, e-mail:loucka@novell.vuzv.cz

THE EFFECT OF AN EXTREME FLOOD ON THE FISH COMMUNITIES IN THE UPPER REACHES OF THE TICHÁ ORLICE RIVER (THE LABE DRAINAGE AREA)*

VLIV EXTRÉMNÍ POVODNĚ NA RYBÍ SPOLEČENSTVA HORNÍ ČÁSTI ŘEKY TICHÁ ORLICE (POVODÍ LABE)

S. Lusk, K. Halačka, V. Lusková

Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Brno, Czech Republic

ABSTRACT: The effect of an extreme flood on fish communities was evaluated in the upper reaches (r. km 78–100) of the Tichá Orlice river. The flood discharge itself lasted 2–3 days in July 1997, the extreme discharges at a level repeating at intervals of 100 years (around $120 \text{ m}^3 \cdot \text{s}^{-1}$) lasted only a few hours. The effect of the flood was evaluated on the basis of quantitative samplings in 4 river sections before and after the flood. The upper reaches of the Tichá Orlice river are populated by a fish community of the *Salmo-Thymallus* type with predominance of *Salmo trutta m. fario*. Except in section 1, the effect of the deluge on the numbers of this species was not destructive. As for *Thymallus thymallus*, the flood had a distinct destructive effect on this species in section 1 and 2. Bottom-dwelling fish species were most distinctly affected by the deluge. The numbers of *Lampetra planeri*, *Barbatula barbatula* and *Cottus gobio* were significantly decreased. The most distinct decrease was recorded in section 1 in which extensive shifts of materials forming the river bed took place. The data obtained indicate that the effect of the flood was different in the particular sections of the river bed. The flow rate is the major decisive factor, decreasing markedly if the water incidentally rises and floods the floodplains beyond the river bed. Another important factor which may significantly affect incidental losses due to the flood is the response of fishes to increased water discharges during the flood. This pertains, above all, to their being capable of seeking flow screens in which to wait until the flood is over and then to return to the river bed after the water level has dropped. There are specific differences in this point.

flood; consequences; fish communities; stream

ABSTRAKT: V horní části řeky Tichá Orlice (ř. km 78–100) došlo v červenci 1997 v důsledku enormních dešťových srážek ve dnech 4. až 8. července k vytvoření povodňových stavů. Úroveň povodňových průtoků narůstala směrem po proudu s časovou prolongací v rozsahu hodin. Extrémních průtoků v měrném profilu Sobkovice (ř. km 81) bylo dosaženo v nočních hodinách 7. července a v ranních hodinách 8. července. Průtok dosahoval Q-100leté vody, která se pro profily v ř. km 78–81 pohybuje na úrovni $120 \text{ m}^3 \cdot \text{s}^{-1}$. Povodeň se vyznačovala rychlým nástupem; vlastní průběh charakterizuje měsíční průtoková křivka pro měsíc červenec v měrném profilu Sobkovice, sestrojená na základě průměrných denních průtoků (obr. 2). V horní části řeky Tichá Orlice jsme vyhodnotili stav rybiho osídlení ve čtyřech úsecích po povodňových průtocích v červenci 1997. Ze tří úseků (č. 1, 2 a 4) jsme měli k dispozici údaje o stavu rybiho osídlení z období před povodněmi. Horní část toku Tiché Orlice je osídlena rybím společenstvem typu *Salmo-Thymallus*. Pstruh obecný se vyskytuje souvisle v celé její horní části. Je hodnocen jako „superdominantní druh“, neboť jeho podíl na abundanci byl v průměru vyšší než 60 % a na biomase dokonce vyšší než 75 %. Absolutní hodnoty abundance pstruha obecného v provedených kvantitativních odlovech se pohybovaly v rozmezí 1 040 až 3 857 ks.ha⁻¹ a biomasa v rozmezí 107,5 až 289,1 kg.ha⁻¹. Stav populací pstruha obecného se ani po povodni nezměnil. Svědčí to o tom, že pstruh obecný je adaptován na proudivé podmínky a je schopen přežít i extrémní průtoky. Výskyt druhého charakteristického druhu, lipana podhorního, není souvislý a je z části závislý na dotačním vysazování násad. U tohoto druhu jsme zaznamenali výrazný pokles v dolních úsecích (č. 1 a 2) sledované části řeky v důsledku povodňových průtoků. Nejvýraznější vliv povodně jsme zjistili u druhů, které jsou svou biologií vázány na dno a dnové sedimenty. Průkazně se snížila početnost mihule potoční, mřenky mramorované a vranky obecné. Nejvýraznější úbytek nastal v úseku, ve kterém došlo v průběhu povodně k největším přesunům materiálů tvořících říční dno (úsek č. 1 – Jablonné nad Orlicí). Nejvýznamnějším faktorem při povodňových stavech je rychlost proudu. V souvislosti s tím má zásadní význam možnost ryb přesunout se na místa s malým proudem či s proudovými stínami, tam vyčkat opadnutí povodně a s odtékající

* This study is a part of research project „Orlice“, supported by the KAV of the Academy of Sciences of the Czech Republic and the research grant reg. no. A6087704 from the Grant Agency of the Academy of Sciences of the Czech Republic.

vodou se vrátit zpět do říčního koryta. Tyto aktivity jsou specifické u jednotlivých druhů a mají rozhodující význam z hlediska důsledků povodně pro jejich populace. Proto jsme téměř žádné změny nezaznamenali v úsecích, kde povodňové průtoky nebyly extrémní (úsek č. 4 v pramenné části), nebo v úsecích, kde došlo k rozlivu vody mimo koryto do údolní nivy (úseky č. 2 a zejména č. 3). Nejvyšší vliv povodně na rybí společenstvo a mihuli potoční jsme zaznamenali v úseku č. 1 (lokality Jablonné nad Orlicí), kde i vliv povodňových průtoků na koryto byl nejvýraznější. Na základě získaných poznatků je možné konstatovat, že vliv povodňových stavů na rybí společenstva v toku je rozdílný v jednotlivých úsecích. Rozhodující jsou rychlost proudu, která závisí na možnosti rozliti do údolní nivy, eroze a transport dnových materiálů a dále možnost ryb vyhledat proudové stíny v břehových partiích či v případné inundaci. V případě rozlivů vody do údolní nivy dochází ke ztrátám na rybách především v těch lokalitách, kde se ryby při opadnutí vody nemohou vrátit zpět do toku.

povodně; důsledky; rybí společenstva; vodní tok

INTRODUCTION

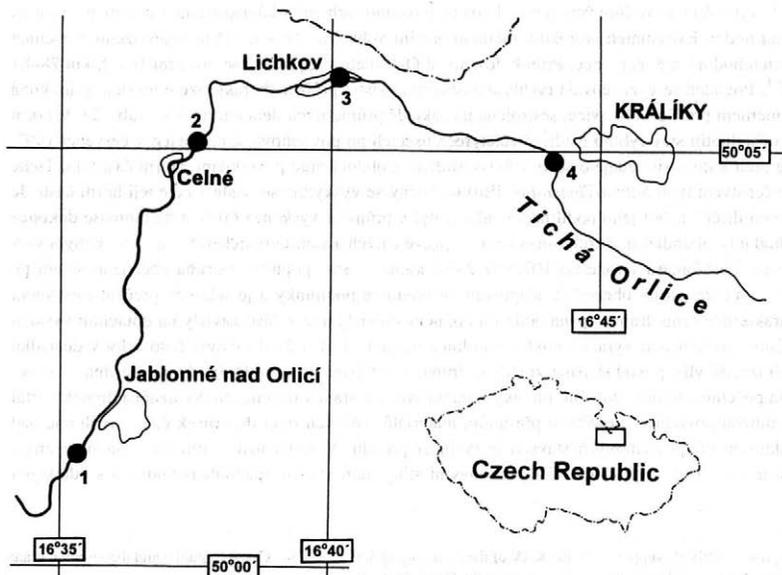
The hydrological regimen is among the basic characteristics of any river system. At the same time, it is the most important factor affecting the development and conditions of the various parts of aquatic biota. Fishes, being animals permanently confined to the aquatic environment, have adapted their biology to the hydrological regimen. Above all, the so-called riverine fish species, living permanently in the flowing environment of a water stream, must be capable of surviving hydrological conditions that vary within short or long periods of time. As regards specific effects and consequences of flood water discharges on fishes, only isolated reports are found in the literature (Čihař, 1976; Harrell, 1978). We utilized the extreme floods that occurred in this country in July 1997 to study their effect on the fish communities in streams. In this contribution, we present an evaluation of the effect of an extreme flood on fish communities inhabiting 4 sections in the upper reaches of the Tichá Orlice river.

MATERIAL AND METHODS

The Tichá Orlice river is a IIIrd order stream, 105.5 km long, with a catchment area of 755.4 km², the annual mean water discharge at the mouth into the Divoká Orlice river attaining 7.02 m³.s⁻¹. The two streams fused form the Orlice river which empties into the Labe (Elbe) river. Our investigations involved 4 sections in the upper part of the Tichá Orlice river, from the profile at Jablonné nad Orlicí (r. km 78.0) up to that at Králíky (r. km 98.6), which already lies in the headwater area of the river. The situation is shown in Fig. 1. In the headwater area upstream of the profile at Lichkov (r. km 92.7) a predominant part of the hydrological network of small tributaries has been canalized as a part of agricultural ameliorations in the last 20 years.

Section No. 1 – Jablonné nad Orlicí, r. km – 78.0,
N-50°01'.21"/E-16°35'.20"

The left bank of the section (165 m long, 11.0 m wide) is stabilized with stonework and alder trees (*Al-*



1. Map showing the upper reaches of the Tichá Orlice river and the sections investigated (No. 1-4)

nus sp.), the right bank is partly flexible, stabilized with willow bushes and alder trees. The section is mostly flowing with rapids, its bottom is largely formed by gravel, boulders and rocks. Sand deposits, previously present along both banks, disappeared in the course of the flood, and the structure and arrangement of the bottom also changed substantially (the amount of gravel and rocks increased). In the section there is a low weir with a wash-out 1 to 1,3 m deep. Samplings were made before the flood, on 12.10.1996, and after it, on 25.9.1997.

**Section No. 2 – Celné, r. km 87,0,
N-50°05'.05"/E-16°37'.31"**

The section (160 m long, 8.0 m wide) lies below a weir with a small water power plant. Its left bank is stabilized with stonework and trees, its right bank passes into a flexible line which, however, was not affected even by the deluge discharge. The eroding and devastating effects of the flood on the river bed in that section were eliminated by the water leaving the river bed and flooding a fairly extensive left-bank floodplain. Samplings were made before the flood, on 12.10.1996 and after it, on 25.9.1997.

**Section No. 3 – Lichkov, r. km 92,7,
N-50°05'.57"/E-16°40'.09"**

The section (155 m long, 6,0 m wide) is partly regulated, passing into a non-regulated natural river bank. In the section, rapids alternate with deeper places, the bank is stabilized with stonework in places, its longitudinal profile is stabilized with alder trees. Banks with numerous hide-outs, bottom sandy in places and gravely and rocky in others. The section is natural in character. It lies in the village of Lichkov, evacuated during the July 1997 flood. The surroundings of the village were flooded up to the 2 m deep over the terrain level. The flood did not markedly change the character of the river bed. There increased sediments of gravel appeared. Sampling was made on 26.9.1997.

**Section No. 4 – Králíky, r. km 98,6,
N-50°04'.55"/E-16°44'.18"**

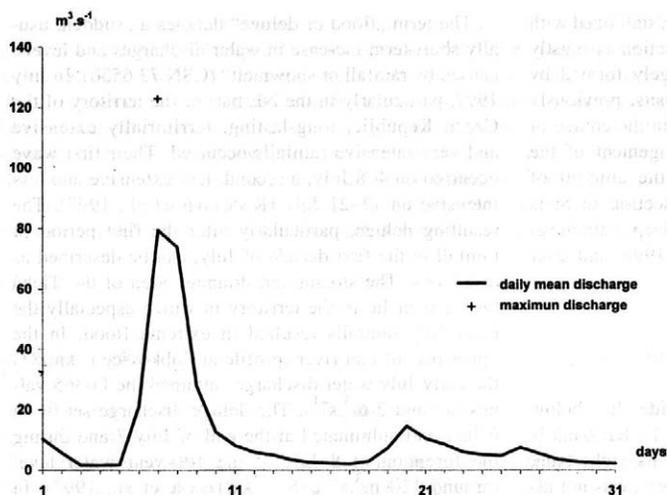
The section (135 m long, 1.80 m wide) has been heavily regulated, its bottom and banks consisting of concrete panels (120 by 80 cm) and the bed being a regular trapezium in profile. In the course of three years (1995–1997) the panels were shifted apart, plants became rooted in the slits, there developed cavities and irregularities that created local rapids, flow screens and hide-outs. Samplings were made before the flood, on 15.9.1995 and after it, on 26.9.1997.

The oxygen content in water varied between 97 and 104% saturation. Water conductivity varied between 180 and 210 μS in the first three sections, and it was below 150 μS in section 4.

The term „flood or deluge“ denotes a „sudden, usually short-term increase in water discharges and levels, caused by rainfall or snowmelt“ (ČSN 73 6530). In July 1997, particularly in the NE part of the territory of the Czech Republic, long-lasting, territorially extensive and very intensive rainfalls occurred. Their first wave occurred on 4–8 July, a second, less extensive and less intensive on 17–21 July (Květoň et al., 1997). The resulting deluge, particularly after the first period of rainfall in the first decade of July, can be described as disastrous. The stream and drainage area of the Tichá Orlice river lie in the territory in which especially the early July rainfalls resulted in extreme flood. In the upper part of that river (profile at Sobkovice r. km 81) the early July water discharges attained the Q-365 values (around $2 \text{ m}^3 \cdot \text{s}^{-1}$). The deluge discharge set in on 6 July and culminated at the end of July 7 and during the forenoon of 8 July at the 100-year water level (around $120 \text{ m}^3 \cdot \text{s}^{-1}$) (Soukalová et al., 1997). In the course of two subsequent days the water discharge decreased to an average of around $10 \text{ m}^3 \cdot \text{s}^{-1}$, and after 11 July to $5 \text{ m}^3 \cdot \text{s}^{-1}$. The second wave of heavy rainfall, around 20 July, increased the water discharge on 19 and 20 July up to $20 \text{ m}^3 \cdot \text{s}^{-1}$. After 21 July the discharge decreased to around $5 \text{ m}^3 \cdot \text{s}^{-1}$. A curve plotted from daily mean water discharge values (Fig. 2) expresses the course and duration of the deluge. Due to the method used to determine the daily mean discharges (i.e. the mean of four measurements taken in the course of 24 hours), the daily mean discharges shown in the curve are about 35% lower on the days of the peak deluge water discharges than are the daily maximum ones.

Stream velocity is the factor that decides the fish stay in the river bed. During deluges the stream velocity differs considerably in different stream sections. If the water leaves the river bed and floods the neighbouring floodplain (e.g. in section 2 and 3) the stream velocity in the bed decreases markedly. Besides, the fish have an opportunity to seek places away from the highest or most rapid stream in the flood, thereby surviving it. In sections where the riverbed is capable of holding the deluge discharge without flooding the surroundings, the stream velocity and its transporting effectiveness are distinctly higher, usually causing shifts of bottom materials and washing off the fish into sections where they can survive the deluge. In our case, section 1 was most heavily affected in this sense. The headwater section (no. 4) was the least affected by the flood, as the capacity of the canalized river bed was high enough to lead away the waters and to prevent critical water discharge situation that could affect the stability of the fish community.

Samples of the fish communities were obtained by electrofishing, using a pulsating DC (160–220V, 0.3–1.2 A) produced by a ZB6 type aggregate made in the Czech Republic. During sampling, the sections investigated were closed at their upper and lower ends with nets 30 by 30mm mesh size. Each section was fished



twice with a 90min break between the fishing runs. Each sample was treated separately and the standard length and total weight were measured in each fish of each species. The status of the fish community in the section was then estimated according to Seber and LeCren (1967), modified for the application of a PC. Fish abundance and biomass were converted to the area of 1 ha. At the same time, the values of species diversity (H') and equitability (E) were computed. In evaluating the dominance of species in a community, we used the classification into 5 groups in which the percentage over 10% is evaluated as eudominant (Losos et al., 1984), and introduced a superdominant category for those cases in which the percentage exceeded 30%.

RESULTS

Before the flood, we found 5 fish species in sections 1, 2 and 4 (Tab. I). The mean species diversity in the sections studied before the flood was 0.9025 ± 0.3683 . After the flood we found in the three sections a total of 8 species. The newly found ones included *Oncorhynchus mykiss*, a species stocked to the stream shortly after the deluge, *Anguilla anguilla* and *Lota lota*, the latter two having been drifted down from sections lying upstream. After the deluge the mean value of species diversity decreased only slightly to 0.8770 ± 0.2833 . The species richness of the fish communities in sections 1, 2 and 4 was very similar (Tab. I).

Before as well as after the flood, the fish communities in sections 1, 2 and 4 were distinctly dominated by *Salmo trutta m. fario*. Before the flood this species accounted for an average of 61.20% of total abundance, and as much as for 78.74% of total biomass. The second species of fishery importance, *Thymallus thymallus*, made up 7.06% of total abundance and 17.55% of total biomass. Important shares in total abundance also

fell on *Barbatula barbatula* (11.30%) and *Cottus gobio* (19.64%). After the flood the absolute number and share of *S. trutta* in total abundance in the sections under study increased to 74.40%, while its share in total biomass remained almost the same, 77.97%. The share of *T. thymallus* decreased slightly to 6.65% and 8.10%. A marked decrease was also observed in another two species which were among the abundant ones previously. The representation of *B. barbatula* in total abundance decreased to 1.16% (previously 11.30%), that of *C. gobio* to 9.49% (previously 19.64%).

The most marked changes were observed in those species which, by their behaviour, are tied to the river bottom and its materials (sand, gravel). In the course of the flood the bottom materials were extensively shifted, causing changes in the numbers of the so-called bottom species. Before the flood, *B. barbatula* occurred in section 1 (314 fish.ha⁻¹) and 4 (627 fish.ha⁻¹). We did not find this species in section 4 after the flood discharges and its numbers decreased considerably (to 106 fish.ha⁻¹) in section 1. A similar drop in numbers was observed in *C. gobio*: before the flood the numbers of this species attained 932 fish.ha⁻¹ in section 1 and 692 fish.ha⁻¹ in section 2. After the flood, only 318 fish.ha⁻¹ were found in section 1 and 548 fish.ha⁻¹ in section 2. The intensity of this drop in the numbers of the above species in the respective stream sections corresponds to the shifts of bottom materials. In section 1 they were almost totally drifted away whereas in section 2, where the waters flooded the neighbouring floodplains, the transporting activity of the discharges was distinctly lower, leaving the bottom almost unchanged. Therefore, the drop in the numbers of *C. gobio* was lower in that section.

Section 3, situated in the village of Lichkov, was investigated only after the flood. During the deluge the village was flooded up to a height of 1.5–2.0 m. From the general point of view, the locality was extremely

I. Fish communities in the sites on the Tichá Orlice river under study before (BF) and after flood (AF) in July 1997. Abundance (*n*) and biomass (kg) are converted to 1 ha water surface of the stream

Species	Loc. 1 (r. km 78.0)				Loc. 2 (r. km 87.0)				Loc. 3 (r. km 92.7)		Loc. 4 (r. km 98.6)			
	BF		AF		BF		AF		AF		BF		AF	
	<i>n</i>	kg	<i>n</i>	kg	<i>n</i>	kg	<i>n</i>	kg	<i>n</i>	kg	<i>n</i>	kg	<i>n</i>	kg
<i>Salmo trutta</i>	1,465	141.18	1,040	106.54	1,325	169.03	1,893	172.25	2,320	215.48	2,269	126.94	3,857	289.12
<i>Oncorhynchus mykiss</i>	–	–	26	10.39	–	–	16	6.25	208	14.38	–	–	331	18.04
<i>Salvelinus fontinalis</i>	59	2.94	175	20.90	–	–	63	9.33	13	3.85	–	–	–	–
<i>Thymallus thymallus</i>	320	49.02	43	6.23	264	48.44	–	–	1,112	162.82	–	–	564	52.77
<i>Rutilus rutilus</i>	–	–	–	–	–	–	–	–	92	16.64	–	–	–	–
<i>Leuciscus cephalus</i>	–	–	–	–	–	–	–	–	51	9.26	–	–	–	–
<i>Phoxinus phoxinus</i>	–	–	–	–	–	–	–	–	361	0.51	–	–	–	–
<i>Gobio gobio</i>	–	–	–	–	–	–	–	–	58	2.31	–	–	–	–
<i>Barbatula barbatula</i>	314	3.20	106	0.35	–	–	–	–	157	0.51	627	4.90	–	–
<i>Anguilla anguilla</i>	–	–	9	0.87	–	–	–	–	13	1.03	–	–	–	–
<i>Lota lota</i>	–	–	–	–	–	–	31	15.23	13	6.67	–	–	–	–
<i>Cotus gobio</i>	932	5.29	318	3.39	692	4.62	548	12.53	–	–	–	–	–	–
Total	3,089	201.63	1,718	148.66	2,281	222.09	2,250	215.90	4,396	433.45	2,896	131.44	4,858	364.16
Species diversity H'	1.2580		1.2038		0.9268		0.7278		1.3943		0.5226		0.6995	
Equitability E	0.7817		0.6186		0.8437		0.4542		0.5815		0.7540		0.5046	

affected by the deluge. That was why we investigated the locality even though no data on the local fish stock were available to us prior to flood. In section 3 we found a total of 11 fish species. In addition to those occurring in the other section under study, section 3 also harboured additional cyprinid species, viz. *Rutilus rutilus*, *Leuciscus cephalus*, *Phoxinus phoxinus* and *Gobio gobio*. The species composition of the rest was much the same as in the other sections, with a predominance of *S. trutta* (Tab. I). In section 3 we found a high representation of *T. thymallus* both in total abundance and total biomass. Compared to the other sections, its total abundance (4,396 fish.ha⁻¹) and, above all, total biomass (433 kg.ha⁻¹) are among the highest (Tab. I), indicating that this section provided good conditions for the fish community to survive the deluge.

DISCUSSION

The hydrological regime of streams is among the basic factors affecting or determining the various aspects of biology of fish species and communities (Holčík, 1996). Concrete data on the effects of flooding on fish communities, fish species or even their different age (size) groups are scarce. Harell (1978) evaluated the response of fish communities to floods in the Devil's River in Texas. While those conditions were different from ours, some of the information is of general validity. He found a marked decrease in species diversity (H') and number of species in the sections under his study. The effect of the flood decreased in the downstream direction, being the least in the lower

reaches of the river. The conclusion, also confirmed by our observations on the Tichá Orlice river, is that in stream sections which can flood the neighbouring floodplains by their high water discharges, the destructive effect of the flood on their fish communities is smaller. The discharge rate in the stream in the river bed is decreased and, at the same time, there is a larger opportunity for the fish to seek places with slower flow even beyond the river bed itself. In relation to incidental losses of fish, the possibility of their returning to the stream with retreating flood waters is of fundamental importance. The behaviour of fish during floods in general in canalized and non-canalized streams has been described by Záleský (1925), accentuating the fishery management in such streams.

Increased water discharges usually cause shifts of brown trout larvae or yearlings in the downstream direction (Kirka, 1969; Lusk, Zdražilík, 1969). In this case, these are natural compensation movements since the fish usually migrate for spawning within considerable distances upstream. We have observed that in the case of brown trout, a species showing distinct territoriality, the fish respond to water discharges increased beyond a tolerable limit by leaving their habitat in the river bed, moving into banks where they survive periods of water discharges above the normal, staying in flow screens (Lusk, 1979). This also explains the stable relation of this species in the fish communities inhabiting the stream sections of the Tichá Orlice river under study. A similar observation of the capability of brown trout to survive flood water discharges was made by Čihař (1976), who evaluated the consequences of flood for the fish communities in the

Mnichovka stream. The author described the flood as a true disaster for *C. gobio* and *B. barbatula*. His observations are in full correspondence with our own ones on the Tichá Orlice river.

Evaluating the impact of the July 1997 deluges on the fish diversity in streams, Lusk et al. (1998a, b) confirm that riverine fish species are relatively resistant and capable of surviving flood discharges, except for those tied to the river bottom and usually showing less mobility. At the same time, the authors point out the possible effects of fish movements (both active migrations and passive drift) in the course of floods on intrapopulation genetic diversity. Comparing the species richness, abundance and biomass of the two most important species, *S. trutta* and *T. thymallus*, found in the sections of the Tichá Orlice river under study, with those found in a similar stream of the Svratka river, also populated by a *Salmo-Thymallus* type fish community, a high degree of agreement is ascertained (Lusk, 1978).

The state of the fish population in the Tichá Orlice reaches under study was investigated at the end of September 1997, i.e. after more than a 2 month interval from the flood situation which occurred during July 1997. Therefore, certain changes in the fish population within the reaches under study as a result of local translocations cannot be excluded. The extraordinary floods afflicted the whole stream of the river Tichá Orlice river. For this reason we suggest that changes in the fish population after the flood resulting from local translocations, except for the species released intentionally (*Oncorhynchus mykiss*, *Salvelinus fontinalis*), were almost minimum. The fish population changes found in the Tichá Orlice reaches under study are considered to be affected, first of all, by the flood.

REFERENCES

ČIHAŘ, J.: Vliv povodně na ichthyofaunu potoka Mnichovky u Senohrab (The effect of flood upon the fish fauna of the Mnichovka Brook near Senohraby). Čas. Nár. Muz., Přir. Vědy, 145, 1976: 223–227 (in Czech, with a summary in German).

HARRELL, H. L.: Response of the Devils River (Texas) fish community to flooding. Copeia, 1978: 60–68.

HOLČÍK, J.: Ecological fish production in the inland delta of the Middle Danube, a floodplain river. Envir. Biol. Fishes, 46, 1996: 151–165.

KIRKA, A.: Experiments with stocking brown trout in mountain streams of northern Slovakia. Práce Labor. Rybářstva, 2, 1969: 219–252.

KVĚTOŇ, V. – SRNĚNSKÝ, R. – VESELÝ, R.: Rozložení srážek při povodních v červenci 1997 (Precipitation distribution during the July 1997 floods). Meteorol. Zpr., 50, 1997: 172–177 (in Czech, with a summary in English).

LOSOS, B. – GULIČKA, J. – LELLÁK, J. – PELIKÁN, J.: Ekologie živočichů (Animal ecology). Praha, SPN 1984. 316 p. (in Czech).

LUSK, S.: Fish stock and angling in the middle course of the Svratka River. Folia Zool., 27, 1978: 71–84.

LUSK, S.: Rocky chutes and the fish stock of stream. Acta Sci. Natur., Brno, 13, 1979: 1–26.

LUSK, S. – ZDRAŽÍLEK, P.: Contribution to the bionomics and production of the brown trout (*Salmo trutta* m. fario L.) in the Lušová Brook. Zool. Listy, 18, 1969: 381–402.

LUSK, S. – LOJKÁSEK, B. – HALAČKA, K. – LUSKOVÁ, V. – PRAŽÁK, O.: Vliv povodní v červenci 1997 na ryby ve vodních tocích (Effect of floods in July 1997 on fish in water streams). In: Proc. Conf. Povodne a protipovodňová ochrana, Banská Štiavnica, 1998: 307–310 (in Czech).

LUSK, S. – HALAČKA, K. – LUSKOVÁ, V. – LOJKÁSEK, B. – ŠLECHTA, V. – PRAŽÁK, O.: Vliv katastrofální povodně v červenci 1997 na biodiverzitu ryb ve vodních tocích (Effect of extreme floods in July 1997 on the fish biodiversity in water streams of the Czech Republic). Biodiverzita ichtyofauny ČR, 1998 (2): in press (in Czech, with a summary in English).

SEBER, F. – LeCREN, E. D.: Estimating population parameters from large catches relative to the population. J. Anim. Ecol., 36, 1967: 631–643.

SOUKALOVÁ, E. – ŘEHÁNEK, T. – ŠIFTAŘ, Z.: Odtoková situace za povodně v červenci 1997 v povodích Odry, Moravy a Labe (Runoff situation in Odra, Morava and Labe basins during the July 1997 floods). Meteorol. Zpr., 50, 1997: 183–190 (in Czech, with a summary in English).

ZÁLESKÝ, M.: Poznámky o vlivu povodní na stav ryb v současných řekách (Notes on the influence of floods on the fish status in contemporary rivers). Českoslov. Rybář., 5, 1925: 11–13 (in Czech).

Received for publication on May 5, 1998
Accepted for publication on July 14, 1998

Contact Address:

Ing. Stanislav Lusk, CSc., Ústav biologie obratlovců AV ČR, Květná 8, 603 65 Brno, Česká republika, tel.: 05/43 21 04 49, fax: 05/43 21 13 46, e-mail: lusk@brno.cas.cz

MEAT EFFICIENCY OF BULLOCKS OF THE BLACK PIED BREED FINISHED TO A LOWER SLAUGHTER WEIGHT*

MASNÁ UŽITKOVOST BÝČKŮ ČERNOSTRAKATÉHO PLEMENE VYKRMOVANÝCH DO NIŽŠÍ PORÁŽKOVÉ HMOTNOSTI

G. Chládek, J. Soutor, I. Ingr, A. Krása

Mendel University of Agriculture and Forestry, Faculty of Agronomy, Brno, Czech Republic

ABSTRACT: Our experiments involved 46 Black Pied bullocks of genotype H1 (minimal proportion of Holstein blood 87.5%) housed in stanchionless sheds and fed a concentrated diet based on mashed cereals; the average weight of carcass meat was 190 kg, carcass weight 366 kg, age 360 days, carcass yield 51.9%, daily gain and net gain 1048 g and 552 g, respectively. Using analysis of variance we evaluated the effect of the weight of carcass meat and average daily body gain on the level of selected parameters of meat efficiency. With a higher weight of carcass meat the weight of hind and forequarters, shank from the hindquarter and shoulder increased highly significantly. The weight of the round and of the rib roast were significantly higher. The body gain had a highly significant effect on a lower weight at slaughter, higher daily gain and net gain. The carcass weight and weight of the shank from the hindquarter were significantly lower, carcass yield was higher.

bullocks; fattening; Black Pied breed; carcass value

ABSTRAKT: U 46 býčků černostrakatého plemene genotypu H1, ustájených volně na pilinové podestýlce a vykrmovaných vysokokonzentrovanou dietou na bázi mačkaného obilí, byla zjištěna průměrná hmotnost jatečně opracovaného těla 190 kg, porážková hmotnost 366 kg, věk 360 dnů, jatečná výtěžnost 51,9 %, denní přírůstek 1 048 g a netto přírůstek 552 g (tab. I). Při průměrné hmotnosti pravých zadních čtvrtí 51,8 kg byla průměrná hmotnost kýty 18,5 kg, nízkého roštěnce 3,6 kg, svíčkové 1,2 kg, klišky 1,8 kg a masitého ořezu 7,0 kg (tab. II). Průměrná hmotnost pravých předních čtvrtí byla 41,4 kg, plece 6,0 kg, krku 4,3 kg, vysokého roštěnce 4,2 kg, klišky 3,5 kg a masitého ořezu 5,3 kg (tab. III). Analýzou rozptylu byl dále hodnocen vliv hmotnosti jatečně opracovaného těla (nižší hmotnost od 170 kg do 189 kg, vyšší od 190 kg do 209 kg) a průměrného denního přírůstku živé hmotnosti (nižší úroveň do 999 g, vyšší úroveň nad 1 000 g). U skupiny s vyšší hmotností jatečně opracovaného těla byl zjištěn vysoce významně vyšší věk při porážce (o 79 dní), vyšší porážková hmotnost (o 44 kg), vyšší hmotnost jatečně opracovaného těla (o 21 kg), vyšší hmotnost zadní čtvrtě (o 5,6 kg) a klišky (o 0,7 kg) a vyšší hmotnost přední čtvrtě (o 5,7 kg) a plece (o 0,5 kg) – tab. III. Průkazně vyšší byla hmotnost kýty (o 0,7 kg) a vysokého roštěnce (o 0,5 kg). Vyšší přírůstek živé hmotnosti měl vysoce průkazný vliv na nižší věk při porážce (o 95 dní), vyšší denní přírůstek (o 283 g) a netto přírůstek (o 164 g). Průkazně nižší byla porážková hmotnost (o 29 kg) a vyšší byla výtěžnost (o 1,1 %). Hmotnost klišky ze zadní čtvrtě byla průkazně nižší (o 0,2 kg). Rozdíly u všech ostatních sledovaných proměnných byly neprůkazné.

býčci; výkrm; černostrakaté plemeno; jatečná hodnota

INTRODUCTION

The objective of the present study was to analyse, on the basis of information from the grant project "Efficient production of veal and young beef", selected results of meat efficiency and quality of carcasses of pure-bred Black Pied bullocks of the H1 genotype, i.e. with a proportion of more than 87.5% of blood of the Holstein breed, the main criterion being a range of weights of carcass meat from 170 kg to 209 kg.

The major part of the production of slaughter bullocks in Europe are animals of dual-purpose breeds, crosses between dairy and meat breeds and partly Friesian and Holstein-Friesian breeds (Faucon, 1986). The animals are fattened between 16 and 18 months of age. In some countries the bullocks of dairy breeds are used for the production of baby beef at the age of about 1 year (north Italy, Spain) and they are fattened mostly with cereals (Jarrige, Béranger, 1992) to 180–220 kg weight of carcass meat, which corresponds to special market demands.

* The study was financially supported by the Grant Agency of the Czech Republic (Grant No. 507/93/1248).

In conditions of the Czech Republic the internal breed structure of the population of Black Pied cattle and its crosses is gradually changing. Since 1985, Holstein bulls have been mostly used for insemination, or bulls with a high genetic proportion of Holstein. A lower competitiveness of slaughter bullocks fattened to a weight of 550–650 kg can be expected, providing opportunities for the application of other systems and methods of beef production (Heinrich, Kögl, 1992).

Conclusions of studies on the fattening of Black Pied bullocks do not always agree with each other. Kahoun (1988) reported that with an increasing genetic proportion of dairy breeds, the meat efficiency decreased, as was expected; results reported by Urban et al. (1981) are similar. Also Averdung et al. (1974) recommended to be careful when using Holstein-Friesian cattle, particularly from overseas. Urban et al. (1976) stated that the main indicators of meat efficiency of Black Pied bullocks at a daily growth rate of 800 g, as well as the F1, F11 and F10 generations, are similar to the Czech Pied cattle. Teslík et al. (1995) studied Black Pied bullocks (N) fattened to 530 kg and found that they could be successfully fattened at a high intensity to a higher carcass weight. Also Chládek et al. (1996) was involved in studies of the meat efficiency of Black Pied bullocks weighing 430–530 kg. The different results are generally based on the effect of various genotypes and proportions of continental or overseas provenances (Golda, Čížek, 1982).

In Slovakia, Nosál and Pavlič (1988) studied the carcass value and associated indicators at a lower carcass weight (350, 400, 450 kg) in crosses of the Slovakian Pied cattle with a high genetic proportion of the Black Pied breed. They found that the carcass yield was 54.76%, 55.80% and 56.54%, respectively, and, on the contrary, that the proportion of 1st class meat decreased. Palanská and Nosál (1989) studied meat quality at low carcass weights in Black Pied cattle.

MATERIAL AND METHODS

Male calves were purchased from herds of Black Pied cattle with a minimal genetic proportion of Holstein cattle of 87.5% (code H1). The calves were housed in stanchionless stalls on sawdust litter. Nutrition was provided for average daily gains of 1300 g in accordance with recommended tabular values for fattening the bulls of dairy breeds (Sommer et al., 1994). The feed ration was based on an *ad libitum* uptake of mashed cereals (wheat + barley 1 : 1) and limited uptake of protein concentrate and alfalfa hay (14.95% of the dry matter of the feed ration). Cereals were prepared (mashed) using cylindrical mashers, alternatively ENGL Potential 55-28 (input 5.5 kW), or ROMILL M 300 (input 5.5 kW).

All the 46 bullocks of the studied group were gradually slaughtered in selected slaughter-houses according

to the intended methods in order to obtain a survey of the carcass value, within the range of 170–209 kg of carcass meat. On the day of slaughter the weight of carcass meat was taken as the basic indicator, and also the weight of kidneys, kidney fat, liver and spleen; 24 hours after slaughter the carcass was cut (division of sides of beef) according to charts of cutting lists (print P 57, Bour. H₃ and H₄).

All results were elaborated by multi-factorial analysis of variance using the STATGRAPHICS programme, version 6.0.

RESULTS

Tab. I shows that the average body weight before slaughter (slaughter weight) of the 46 bullocks was 366 kg; the weight of carcass meat was 190 kg, giving a carcass yield of 51.9%. The average age at slaughter was 360 days, the average daily gain of the experimental animals up to this age was 1048 g and net gain was 552 g.

Comparisons of both sub-groups (Tab. I) show that the carcass weight, age at slaughter and weight of carcass meat were highly significantly higher, which can logically be explained, while the differences in carcass yields, average daily gain and net gain were insignificant. The levels of average daily gains were highly significantly higher, as expected, than were the net gains, the carcass yields were significantly higher with a highly significantly lower age at slaughter and significantly lower body slaughter weight.

Results in Tab. II show that the average weight of right hindquarters was 51.8 kg, the weight of round being 18.5 kg, short loin 3.6 kg, sirloin 1.2 kg, shank 1.8 kg and total meat trimmings 7.0 kg. Due to the highly significantly higher weight of carcass (Tab. I), the weights of the entire hindquarter and shank were highly significantly higher and the weight of round was significantly higher. The weights of short loin, sirloin and meat trimmings were not significant, although the trends in short loin and meat trimmings were very marked (Tab. II). The effect of the average daily gain on the weights of the individual selected parts was not statistically significant, with the exception of shank (Tab. II). This significance could be associated with differences shown in Tab. I (carcass weight) and in Tab. II (weight of hindquarters).

In terms of the forequarters (Tab. III) of bullocks of the sub-group with higher weights of carcass meat, the weights of forequarters and shoulder were highly significantly higher, the weight of rib roast significantly higher. The differences of the other values were insignificant. All the differences with a lower or higher average daily gain were also statistically insignificant.

In terms of the weights of forequarters and hindquarters (Tabs. II and III), the weight of the forequarters (41.4 kg) represented 44.4% and of the hindquarters (51.8 kg) relatively 55.6%.

I. Selected indicators of the fattening performance of the studied group of bullocks

Indicators	Units	\bar{x}	$s_{\bar{x}}$	V(%)	Carcass weight (kg)		Daily weight gain (g/day)	
					lower	higher	lower	higher
					170-189	190-209	less than 999	above 1000
Number	head				25	21	20	26
Slaughter weight	kg	366	27.3	7.45	346 A	390 B	383 a	354 b
Age at slaughter	days	360	64.5	17.9	324 A	403 B	414 A	319 B
Carcass weight	kg	190	11.9	6.26	180 A	201 B	196	185
Carcass yield	%	51.9	1.75	3.37	52.1	51.6	51.2 a	52.3 b
Daily gain	g	1048	197	18.8	1105	979	888 A	1171 B
Net gain	g	552	113	20.5	584	513	459 A	623 B

A, B = $P < 0.01$; a, b = $P < 0.05$

II. Weight of hindquarters and selected parts of carcass meat of bullocks

Indicators	Units	\bar{x}	$s_{\bar{x}}$	V(%)	Carcass weight (kg)		Daily weight gain (g/day)	
					lower	higher	lower	higher
					170-189	190-209	less than 999	above 1000
Number	head				25	21	20	26
Hindquarter	kg	51.8	3.89	7.33	49.3 A	54.9 B	53.4	50.7
Round	kg	18.5	2.6	14.05	18.2 a	18.9 b	18.3	18.6
Short loin	kg	3.6	0.5	13.88	3.5	3.8	3.7	3.6
Sirlon	kg	1.2	0.17	14.17	1.2	1.2	1.3	1.2
Shank	kg	1.8	0.65	36.11	1.5 A	2.2 B	2.2 a	1.6 b
Meat trimmings	kg	7.0	3.02	43.14	6.4	7.7	7.3	6.8

A, B = $P < 0.01$; a, b = $P < 0.05$

III. Weight of forequarters and selected parts of carcass meat of bullocks

Indicators	Units	\bar{x}	$s_{\bar{x}}$	V(%)	Carcass weight (kg)		Daily weight gain (g/day)	
					lower	higher	lower	higher
					170-189	190-209	less than 999	above 1000
Number	head				25	21	20	26
Forequarter	kg	41.4	4.79	11.57	38.8 A	44.5 B	44.0	39.5
Shoulder	kg	6.0	0.75	12.5	5.8 A	6.3 B	6.1	5.9
Neck	kg	4.3	0.88	20.46	4.2	4.5	4.5	4.2
Rib roast	kg	4.2	0.8	19.05	4.0 a	4.5 b	4.4	4.1
Shank	kg	3.5	0.65	18.6	3.4	3.7	3.7	3.4
Meat trimmings	kg	5.3	2.36	44.52	4.8	6.0	5.7	5.1

A, B = $P < 0.01$; a, b = $P < 0.05$

DISCUSSION

The present study provides basic information about results of meat efficiency expected when fattening Black Pied bullocks in the Czech Republic, gradually including more breeding bulls of the extremely dairy Holstein cattle in the herds. It shows the absolute lower level of fattening, sometimes indicated as baby beef, as reported by Jarrige and Béranger (1992) for instance for Italy and Spain; in our case also when using high amounts of cereals in the feed ration.

The carcass yield of bullocks of the expressively dairy type in the studied group of animals is very close to values found by Anderson et al. (1991) in Danish Black Pied cattle. With the same slaughter weight (350 kg) given by Nosál and Pavlič (1988), in our investigations the carcass yield of bullocks was by 2.86% lower, which was due to a certain degree of genetic proportion of the combined breed in animals used by the authors in the present experiments.

The level of average daily gains of all the bullocks of the group studied (1048 g) and of animals of the

sub-group where the weight of the carcass meat was lower (1105 g) corresponds with the results of Arpacik et al. (1994). The results of the present study in the proportion of the weight of fore and hindquarters (44.4% and 55.6%, respectively) differ considerably from general values for bulls given by Dvořák (1987) (i.e. 56.6% and 43.4%, respectively). Also results achieved by Urban et al. (1976) and Teslík et al. (1995) with the same breed or with crosses with its high genetic proportion are different, although the body weight was virtually the same (Nosál, Pavlič, 1988). The conclusions of Kahoun (1988) and Urban et al. (1981) confirm our results on the percentage of carcass yield.

REFERENCES

- ANDERSON, H. F. – KROHN, C. C. – FOLDAGER, J. – MUNKSGAARD, L. – KLAstrup, S.: Influence of housing and feeding on behaviour, feed intake, growth, carcass and meat quality. Beret. St. Husdybrugsforsog, 1991, no. 700. 33 p.
- ARPACIK, R. – NAZLIGUL, A. – BEYHAN, Z. – ATASOY, F.: The effect of initial weight on fattening traits and economic efficiency in Turkish Brown bulls. Lalahan – Hayvancilik – Arastirma – Enstitusu – Dergisi, 34, 1994, (1–2): 79–89.
- AVERDUNG, G. et al.: Verlaunfige Ergebnisse aus der Kreuzung von Rotbunten Holstein Friesien mit Fleckvieh in Bayern. In: 25. Jahrestagung der Europäischen Vereinigung für Tierzucht, Kopenhagen, 1974: 12–15.
- DVOŘÁK, Z.: Nutritional evaluation of meat of carcass animals. 1st ed. Praha, SNTL 1987. 272 p.
- FAUCON, A.: Situation actuelle et évolution récente des différents types de production de viande bovine et leur marché. In: MICOL, D. (ed.): Production de Viande Bovine. Paris, I.N.R.A. 1986: 7–32.
- GOLDA, J. – ČÍZEK, J.: Meat efficiency of bulls crossed with Black Pied cattle. Živoč. Vyr., 27, 1982: 345–352 (in Czech).
- HEINRICH, I. – KÖGL, H.: Rindfleischerzeugung in Europa. Schiftenreihe des Bundesministers für Ernährung, Landwirtschaft und Forsten. Heft 409. Landwirtschaftsverlag GmbH 4400 Münster – Hiltrup 1992. 179 p.
- CHLÁDEK, G. – SOUTOR, J. – INGR, I. – KRÁSA, A.: Meat efficiency of bullocks of the Black Pied breed fattened to 430–530 kg of body weight. Acta Univ. Agric. et Silv. Mendel. Brun. (Brno), XLV, 1997 (1): 13–18.
- JARRIGE, R. – BÉRANGER, C.: Beef Cattle Production. World Animal Science, C 5. Amsterdam, Elsevier 1992. 487 p.
- KAHOUN, J. et al.: Intensification of production of slaughter cattle. Praha, SZN 1988. 256 p. (in Czech).
- NOSÁL, V. – PAVLIČ, M.: Carcass quality of bulls with a large proportion of Dutch Black Pied inheritance, finished to lower body weights. Živoč. Vyr., 33, 1988: 809–820 (in Slovak).
- PALANSKÁ, O. – NOSÁL, V.: Meat quality of young bulls with high heritable share of Black Pied Lowland breed at lower live weight. Poľnohospodárstvo, 35, 1989: 250–258 (in Slovak).
- SOMMER, A. et al.: Nutrient requirements and tables of nutrient value of ruminant feed. 1st ed. Pohořelice, ČZS VÚVZ 1994. 198 p.
- SOUTOR, J. – INGR, I. – CHLÁDEK, G. – KRÁSA, A.: Efficient production of veal and young beef. [Research project 507/93/1248.] Praha, Grant Agency of the Czech Republic 1995. 26 p.
- TESLÍK, V. – BURDA, J. – URBAN, F. – BARTOŇ, L. – ŘEHÁK, D.: Meat efficiency of bulls of Bohemian Spotted and Black Pied cattle under intensive fattening to weight of 530 kg. Živoč. Vyr., 40, 1995: 227–232 (in Czech).
- URBAN, F. – DVOŘÁČEK, M. – VOLEK, J.: Results of studies of meat efficiency in crossing with Black Pied Lowland cattle. Živoč. Vyr., 21, 1976: 103–110 (in Czech).
- URBAN, F. – DVOŘÁČEK, M. – BURDA, J.: Crossing the Bohemian Spotted cattle with bulls of the Black Pied Lowland breed – meat efficiency of bulls and heifers. Živoč. Vyr., 26, 1981: 15–22 (in Czech).

Received for publication on April 7, 1998

Accepted for publication on May 19, 1998

Contact Address:

Ing. Gustav Chládek, CSc., Mendelova zemědělská a lesnická univerzita, Ústav chovu hospodářských zvířat, Zemědělská 1, 613 00 Brno, Česká republika, tel.: 05/45 13 32 11, fax: 05/45 21 20 44

INSTRUCTIONS FOR AUTHORS

Original scientific papers, short communications, and selectively reviews, that means papers based on the study of technical literature and reviewing recent knowledge in the given field, are published in this journal. Published papers are in Czech, Slovak or English. Each manuscript must contain a short and a longer summary (including the key words).

The author is fully responsible for the originality of his paper, for its subject and formal correctness. The author shall make a written declaration that his paper has not been published in any other information source.

The board of editors of this journal will decide on paper publication, with respect to expert opinions, scientific importance, contribution and quality of the paper.

The paper extent shall not exceed 15 typescript pages, including tables, figures and graphs.

Manuscript layout shall correspond to the State Standard ČSN 88 0220 (quarto, 30 lines per page, 60 strokes per line, double-spaced typescript). A PC diskette should be provided with the paper, written in an editor program, preferably T602, and with graphical documentation. Tables, figures and photos shall be enclosed separately. The text must contain references to all these annexes.

The **title** of the paper shall not exceed 85 strokes. Subtitles of the papers are not allowed either.

Abstract is an information selection of the contents and conclusions of the paper, it is not a mere description of the paper. It must present all substantial information contained in the paper. It shall not exceed 170 words. It shall be written in full sentences, not in form of keynotes, and comprise base numerical data including statistical data. It must contain key words. It should be submitted in English and if possible also in Czech or Slovak.

Introduction has to present the main reasons why the study was conducted, and the circumstances of the studied problems should be described in a very brief form.

Review of literature should be a short section, containing only literary citations with close relation to the treated problem.

Only original method shall be described, in other cases it is sufficient enough to cite the author of the used method and to mention modifications of this method. This section shall also contain a description of experimental material.

In the section **Results** figures and graphs should be used rather than tables for presentation of quantitative values. A statistical analysis of recorded values should be summarized in tables. This section should not contain either theoretical conclusions or deductions, but only factual data should be presented here.

Discussion contains an evaluation of the study, potential shortcomings are discussed, and the results of the study are confronted with previously published results (only those authors whose studies are in closer relation with the published paper should be cited). The sections Results and Discussion may be presented as one section only.

The citations are arranged alphabetically according to the surname of the first author. References in the text to these citations comprise the author's name and year of publication. Only the papers cited in the text of the study shall be included in the list of references. All citations shall be referred to in the text of the paper.

If any abbreviation is used in the paper, it is necessary to mention its full form at least once to avoid misunderstanding. The abbreviations should not be used in the title of the paper nor in the summary.

The author shall give his full name (and the names of other collaborators), academic, scientific and pedagogic titles, full address of his workplace and postal code, telefon and fax number or e-mail.

POKyny PRO AUTORY

Časopis uveřejňuje původní vědecké práce, krátká sdělení a výběrově i přehledné referáty, tzn. práce, jejichž podkladem je studium literatury a které shrnují nejnovější poznatky v dané oblasti. Práce jsou uveřejňovány v češtině, slovenštině nebo angličtině. Rukopisy musí být doplněny krátkým a rozšířeným souhrnem (včetně klíčových slov).

Autor je plně odpovědný za původnost práce a za její věcnou i formální správnost. K práci musí být přiloženo prohlášení autora o tom, že práce nebyla publikována jinde.

O uveřejnění práce rozhoduje redakční rada časopisu, a to se zřetelem k lektorským posudkům, vědeckému významu a přínosu a kvalitě práce.

Rozsah vědeckých prací nemá přesáhnout 15 stran psaných na stroji včetně tabulek, obrázků a grafů. V práci je nutné používat jednotky odpovídající soustavě měrových jednotek SI (ČSN 01 1300).

Vlastní úprava rukopisu má odpovídat státní normě ČSN 88 0220 (formát A4, 30 řádek na stránku, 60 úhozů na řádku, mezi řádky dvojitě mezery), k rukopisu je vhodné přiložit disketu s prací pořízenou na PC v některém textovém editoru, nejlépe v T602, a s grafickou dokumentací. Tabulky, grafy a fotografie se dodávají zvlášť, nepodlepují se. Na všechny přílohy musí být odkazy v textu.

Pokud autor používá v práci zkratky jakéhokoliv druhu, je nutné, aby byly alespoň jednou vysvětleny (vypsány), aby se předešlo omylům. V názvu práce a v souhrnu je vhodné zkratky nepoužívat.

Název práce (titul) nemá přesáhnout 85 úhozů. Jsou vyloučeny podtitulky článků.

Krátký souhrn (Abstract) je informačním výběrem obsahu a závěru článku, nikoliv však jeho pouhým popisem. Musí vyjádřit všechno podstatné, co je obsaženo ve vědecké práci, a má obsahovat základní číselné údaje včetně statistických hodnot. Musí obsahovat klíčová slova. Nemá překročit rozsah 170 slov. Je třeba, aby byl napsán celými větami, nikoliv heslovitě. Je uveřejňován a měl by být dodán ve stejném jazyce jako vědecká práce.

Rozšířený souhrn (Abstract) je uveřejňován v angličtině, měly by v něm být v rozsahu cca 1–2 strojopisných stran komentovány výsledky práce a uvedeny odkazy na tabulky a obrázky, popř. na nejdůležitější literární citace. Je vhodné jej (včetně názvu práce a klíčových slov) dodat v angličtině, popř. v češtině či slovenštině jako podklad pro překlad do angličtiny.

Úvod má obsahovat hlavní důvody, proč byla práce realizována a velmi stručnou formou má být popsán stav studované otázky.

Literární přehled má být krátký, je třeba uvádět pouze citace mající úzký vztah k problému.

Metoda se popisuje pouze tehdy, je-li původní, jinak postačuje citovat autora metody a uvádět jen případné odchylky. Ve stejné kapitole se popisuje také pokusný materiál.

Výsledky – při jejich popisu se k vyjádření kvantitativních hodnot dává přednost grafům před tabulkami. V tabulkách je třeba shrnout statistické hodnocení naměřených hodnot. Tato část by neměla obsahovat teoretické závěry ani dedukce, ale pouze faktické nálezy.

Diskuse obsahuje zhodnocení práce, diskutuje se o možných nedostacích a práce se konfrontuje s výsledky dříve publikovanými (požaduje se citovat jen ty autory, jejichž práce mají k publikované práci bližší vztah). Je přípustné spojení v jednu kapitolu spolu s výsledky.

Literatura musí odpovídat státní normě ČSN 01 0197. Citace se řadí abecedně podle jména prvních autorů. Odkazy na literaturu v textu uvádějí jméno autora a rok vydání. Do seznamu se zařadí jen práce citované v textu. Na práce v seznamu literatury musí být odkaz v textu.

Na zvláštním listě uvádí autor plné jméno (i spoluautorů), akademické, vědecké a pedagogické tituly a podrobnou adresu pracoviště s PSČ, číslo telefonu a faxu, popř. e-mail.

CONTENTS

Genetics and Breeding

- Chobotová E., Dobálová M., Foltys V.: Genotypic frequencies of four polymorphous systems of milk proteins in Slovakian Pied and Pinzgau breeds (in Slovak) 497

Nutrition and Feeding

- Demeterová M., Vajda V.: The effect of chemically treated grains on ruminal fermentation (in Slovak) 503
- Zobač P., Kumprecht I., Prokop V., Čmolík J.: Use of rapeseed meal and lecithin slops in diets for broiler chicks (in English) 511
- Szlamińska M., Węgleńska T., Hamáčková J., Kouřil J., Kozák P., Adámková I.: Passage time of *Artemia* nauplii through the gut of tench (*Tinca tinca* L.) larvae at 22 °C (in English) 521
- Loučka R., Machačová E., Homolka P., Moravcová J., Čeřovský M., Voldřich M.: Effect of probiotic-enzymatic additive with glucose oxidase on fermentation of forages ensiled under low content of dry matter (in English) 525

Ecology

- Lusk S., Halačka K., Lusková V.: The effect of an extreme flood on the fish communities in the upper reaches of the Tichá Orlice river (the Labe drainage area) (in English) 531

Animal Products

- Chládek G., Soutor J., Ingr I., Krása A.: Meat efficiency of bullocks of the Black Pied breed finished to a lower slaughter weight (in English) 537

OBSAH

Genetika a šlechtění

- Chobotová E., Dobálová M., Foltys V.: Frekvencia genotypov štyroch polymorfných systémov mliečnych bielkovín u plemien slovenské strakaté a pinzgauské 497

Výživa a krmení

- Demeterová M., Vajda V.: Vplyv lúhovaných zrnín na bachorovú fermentáciu 503
- Zobač P., Kumprecht I., Prokop V., Čmolík J.: Využití řepkového extrahovaného šrotu a lecitinových kalů ve výživě kuřecích brojlerů 511
- Szlamińska M., Węgleńska T., Hamáčková J., Kouřil J., Kozák P., Adámková I.: Doba průchodu nauplií artémie střevem larev lina obecného (*Tinca tinca* L.) při teplotě 22 °C 521
- Loučka R., Machačová E., Homolka P., Moravcová J., Čeřovský M., Voldřich M.: Vliv probioticko-enzymatického aditiva s glukózooxidázou na fermentaci pícnin silážovaných při nízkém obsahu sušiny 525

Ekologie

- Lusk S., Halačka K., Lusková V.: Vliv extrémní povodně na rybí společenstva horní části řeky Tichá Orlice (povodí Labe) 531

Živočišné produkty

- Chládek G., Soutor J., Ingr I., Krása A.: Masná užitkovost býčků černostrakatého plemene vykrmovaných do nižší porážkové hmotnosti 537