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Effect of herbal mixture in beef cattle diets on fattening performance and nutrient digestibility

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Abstract: *Effect of herbal mixture in beef cattle diets on fattening performance and nutrient digestibility.* The aim of the study is to evaluate the impact of herbal mixture addition in beef cattle diet on daily weight gain, feed utilization and the nutrient digestibility. The study was performed on 16 Limousine bulls during the fattening period from 100 to 650 kg of body weight. The animals were divided into two groups: a control (C) and experimental (E) group. All experimental bulls received the same daily rations composed of basal feeds and a concentrate mixture. The experimental factor was a certified mixture of dried chopped herbs (the author's own elaboration): Echinacea (*Echinacea purpurea* Moench), garlic (*Allium sativum* L.), thyme (*Thymus vulgaris*), caraway (*Carum carvi*), and liquorice (*Glycyrrhiza glabra*), given additionally to the rations, in the amount of 3% of the predicted daily dry matter intake. During the study, the feed intake, animal weight gain, feed utilization per 1 kg of body weight gain, and nutrient digestibility were determined. The digestibility study was performed with the indicator method using acid-insoluble ash (AIA) as internal indicator. The addition of herbs improved animals' performance. Higher daily gains in the experimental group of animals (1,194 g per day animal daily), compared to those fed without the addition of herbs (982 g per animal daily), were found with simultaneous better feed utilization for 1 kg of body weight gain (5.01 kg in the experimental group, 5.94 kg in the control group). Higher apparent protein and fat digestibility coefficients were noted in the animals from the experimental group (by 1.3 and 2.5 percentage points, respectively), compared to the control ones. In conclusion at least a 3% addition of herbal mixture containing Echinacea, garlic, thyme, caraway, and liquorice can be recommended in beef cattle diet in order to improve the fattening performance. The addition of herbs improves animals' performance. Higher daily gains in the experimental group of animals, with simultaneous better utilization of feed per 1 kg of body weight gain, were found.

Key words: beef cattle, herbs, digestibility, fattening performance

INTRODUCTION

Livestock production has a significant impact on the natural environment. The new legal restrictions regarding environmental standards and increasing awareness of risks and consequences of intensified animal production generate increased interest in this subject. Thus, improved utilization of feed ingredients, including reduction of excretion of biogenic elements from faeces, has become one of the most important issues in terms of environmental and economic aspects.

In ruminants, maintenance of an optimal balance between the particular groups of ruminal microorganisms affects the metabolism and utilization of nutrients and, consequently, influences the productivity of animals (Castillo et al. 2000, Ivan et al. 2000, Łozicki and Dymnicka 2001, Patra and Saxena 2010). The use of phytobiotics as natural stimulants

is one of the methods to improve feed utilization (Klebaniuk et al. 2011).

The aim of the study is to evaluate the impact of herbal mixture addition in beef cattle diet on daily weight gain, feed utilization and the nutrient digestibility.

MATERIAL AND METHODS

The study was conducted on herd of Limousin cattle managed under organic conditions. Materials for the research consisted of 16 animals: 8 in each control (C) and experimental (E) group, were randomly selected to the study (Table 1). The animals were fattened from approx. 100 kg to min. 650 kg body weight. In each group, 8 animals were assigned to 4 mini-quarters in a pasture, and during the winter season the animals were divided into 4 boxes, 2 animals in each. During the study, the animals received green forage (replaced with haylage during winter period) and meadow hay given *ad libitum*, and concentrate mixture (barley, oats, triticale, and fodder peas in the proportion of 25, 35, 25, and 13%, respectively), and a 2% mineral-vitamin mixture given in amounts to cover animal requirements according to Strzetelski et al. (2014). The animals had constant access to licks and water. A certified mixture of dried chopped herbs (S): Echinacea (*Echinacea purpurea* Moench), garlic (*Allium sativum* L.), thyme (*Thymus vulgaris*), caraway (*Carum carvi*), and liquorice (*Glycyrrhiza glabra*) (35, 20, 15, 15, and 15%, respectively) was the experimental factor (Klebaniuk et al. 2012). It was added to the rations in the amount of 3% of the predicted daily dry matter intake according to Strzetelski et al. (2014). The concentrate mixtures and herbal supplements were given to the feeders, which were set on the quarters in the pastures or in the boxes.

TABLE 1. Experiment design

Body weight	Control group (C)	Experimental group (E)
100–650 kg	roughages and concentrate mixture	roughages and concentrate mixture and ecological herbal mixture (S)*
n	8 (4 mini-quartes × 2 animals)	8 (4 mini-quartes × 2 animals)

*S – ecological herbal mixture (the author's own elaboration): Echinacea (*Echinacea purpurea* Moench.), garlic (*Allium sativum* L.), thyme (*Thymus vulgaris*), caraway (*Carum carvi*), and liquorice (*Glycyrrhiza glabra*).

During the study, the feed intake, animal weight gain, feed utilization per 1 kg of body weight gain, and nutrient digestibility were determined. The assessment of the amount of green forage was evaluated with the Różycki method (Skomiał 1997), and other roughages were monitored every two months in three-day cycles. The intake of the concentrate mixture was monitored daily by weighing the amount of feed given to the animals and the leftover feed in each pen. The animals were weighed every two

months. Feed samples were collected for chemical analysis (the green forage green – on a monthly basis, whereas the remaining feeds each time when the faeces were taken for apparent digestibility determination). The contents of basic nutrients, i.e. dry matter (d.m.), crude protein, crude fibre, ether extract, and crude ash in roughages, concentrate mixtures, herbs, and faeces were analysed according to the AOAC (2012) standards. The nutritive value of feed ration components was calculated on the basis of their chemical composition using programme Winwar, ver. 2.1.3.13. Apparent digestibility of nutrients was determined for each mini-quarters or box four times: at the beginning of the experiment, when the animals reached body weight approx. 250, 450, and 650 kg. Collection of representative samples of faecal was conducted in accordance with the instructions given by Rogulski (1997). Briefly, faecal samples containing approx. 200 g of pooled fresh faeces in each mini-quarter or box were taken twice a day at the end of each observation period. Fresh faecal samples were mixed thoroughly, dried at 55°C for 48 h, and then subjected to further analysis. The digestibility coefficients were estimated using the indicator method using the naturally occurring indigestible internal indicator AIA (acid-insoluble ash) according to the Regulation of the Polish Minister of Agriculture and Rural Development of 2 December 2004 on methods of determining the content of nutrients and feed additives in feedstuffs, premixes, feed mixtures and medical feeds. Apparent digestibility coefficients (ADC) were calculated using the following equation:

$$ADC = 100 - 100 \times \frac{I_{feed}}{I_{feces}} \times \frac{N_{feces}}{I_{feed}}$$

where:
ADC – apparent digestibility coefficient;
I_{feed} – indicator content in the feed;
I_{faeces} – indicator content in the faeces;
N_{feed} – nutrient content in the feed;
N_{faeces} – nutrient content in the faeces.

The results were subjected to analysis using Statistica ver. 6.0, while the significances of differences between mean values of the analysed parameters were set with the Tukey test ($P \leq 0.05$).

RESULTS AND DISCUSSION

The chemical composition and nutritional value of ration components (Table 2) were typical for cattle feeds (Strzetelski et al. 2014). Similarly, the chemical composition of the herbal mixture used as the experimental factor was not significantly different from the values reported in the literature (Klebaniuk et al. 2013).

Previous studies on cattle (Klebaniuk et al. 2012) or lambs (Krusiński et al. 2004) proved the positive impact of herbal mixtures on daily body weight gains and feed utilization. Animals of group E receiving 3% addition of herbs to the ration were characterized by significantly higher ($P \leq 0.05$) daily gains; at the same time, a lower average concentrate utilization per 1 kg of body weight gain ($P \leq 0.05$) was noted (Table 3). There was a trend ($P = 0.089$) towards lower utilization of roughages per 1 kg of body weight gain.

TABLE 2. The chemical composition and nutritional value of ration components

Specification		Feed			
		green forage	haylage	concentrate mixture	ecological herbal mixture (S)*
Dry matter (%)		17.84	46.40	87.96	87.12
In 1 kg of dry matter					
Crude protein (g)		203.56	154.74	170.30	142.10
Crude fiber (g)		235.33	315.73	54.34	248.74
Ether extract (g)		37.83	26.51	18.53	19.97
Nitrogen-free extract (g)		429.05	400.86	704.75	476.70
PDI (g)**	PDIE (g)	79	72	138	91
	PDIN (g)	74	91	164	87
UFV**		0.75	0.77	1.21	0.76
LFU**		0.99	1.06	–	–

*S – ecological herbal mixture (the author's own elaboration): Echinacea (*Echinacea purpurea* Moench), garlic (*Allium sativum* L.), thyme (*Thymus vulgaris*), caraway (*Carum carvi*), and liquorice (*Glycyrrhiza glabra*).
**PDI – protein truly digestible in the small intestine (PDIE – when energy limits microbial protein synthesis, PDIN – when N limits microbial protein synthesis), UFV – feed unit for maintenance and meet production, LFU – fill units for cows.

TABLE 3. Fattening performance

Item	Control group (C)	Experimental group (E)	*SEM*
The average body weight at the beginning of the experiment (kg/animal)	128	126	0.789
The average body weight at the end of the experiment (kg/animal)	510	537	5.271
Body weight gains (g)	982[b]	1 194[a]	43.66
Roughages intake (kg d.m./day/animal)	9.27[b]	10.93[a]	0.317
Concentrate mixture intake (kg d.m./day/animal)	5.83	5.98	0.034
Utilization of roughages for body weight gain (kg d.m./kg body weight)	9.44	9.15	0.067
Utilization of concentrate mixture for body weight gain (kg d.m./kg body weight)	5.94[a]	5.01[b]	0.179

[a, b]– values with different letters differ significantly between the groups ($P \leq 0.05$).

Herbal mixtures used in cattle diets have many positive properties (Łozicki et al. 2006). Biologically active substances contained in herbs (i.e. alkaloids, glycosides, phenols, saponins, tannins, coumarins, essential oils, bitterness, and locks) or preparations produced on the basis of herbs affect a number of

physiological aspects that contribute to improvement of rumen microflora and the function of the rumen or stimulate metabolism in the organism (Klebaniuk 2011). The animals of group E utilized the feed nutrients more efficiently than group C. This was confirmed in the apparent digestibility coefficients of nutrients (Table 4).

Protein is the most expensive and one of the most important nutrients in animal nutrition. Due to the presence of microflora in the rumen, ruminants have an ability to use not only the protein supplied in the feed, but also microbial protein. Efficient microbial protein synthesis in the rumen can proceed while maintaining the optimal conditions in the ru-

TABLE 4. Apparent digestibility coefficients of nutrients (%)

Ingredient	Average body weight of animals during samples collection (kg)	Control group (C)	Experimental group (E)	*SEM*
Organic matter	100	74.2	73.8	0.603
	250	73.2	74.0	0.721
	450	76.2	76.8	0.507
	650	77.1	76.3	0.613
	mean	75.1	75.2	0,589
Crude protein	100	73.1	73.5	0.608
	250	72.7	73.9	0.593
	450	74.2	75.1	0.615
	650	73.6[b]	76.3[a]	0.624
	mean	73.4	74.7	0.492
Crude fibre	100	60.2	61.3	0.443
	250	61.4	60.8	0.492
	450	64.1[a]	60.4[b]	0.420
	650	63.7	62.2	0.395
	mean	62.4	61.2	0.376
Ether extract	100	71.8	72.1	0.524
	250	72.5	74.8	0.591
	450	73.1[b]	76.7[a]	0.449
	650	74.0[b]	77.8[a]	0.502
	mean	72.8[b]	75.3[a]	0.487
Nitrogen free extracts	100	81.8	82.7	0.671
	250	83.4	85.2	0.634
	450	85.4	85.7	0.693
	650	84.9	86.3	0.612
	mean	83.9	85.0	0.530

[a, b] – values in the rows with different letters differ significantly (P <0.05).

men, among others the appropriate level and type of ruminal available energy and the structure of feed rations (Winnicki et al. 2012). Improved utilization of feed and microbial protein in the intestines of ruminants leads to reduction of the amount of nitrogen excreted in faeces, thereby decreasing emission of this element to the environment. In this study, the protein apparent digestibility coefficients were higher in the experimental animal group than in the control (from 0.4 to 3.3 percentage points) – Table 4. This finding confirms the investigations carried out by Wanapat et al. (2008), where higher protein digestibility was reported in a group of ruminants treated with herbal supplements, compared to the control group. However, in our study, the differences between the groups were found to be statistically significant only in the last period of fattening.

Due to stimulation of saliva secretion as well as enhancement of the synthesis of bile acids in the liver and excretion thereof in bile, herbs may have a beneficial effect on the digestion and absorption of lipids. Many active substances in herbs stimulate the function of pancreatic enzymes (lipases, amylases, and proteases) and some increase the activity of digestive enzymes of the gastric mucosa (Srinivasan 2005). In ruminants, also rumen activity is affected by modifying the numbers and species of microorganisms in the rumen (Busquet et al. 2005, Patra and Saxena 2010). The herbal mixtures tested in our trial elevated the digestibility of dietary fat determined as ether extract (Table 4). Comparable results, i.e. a significant increase in the digestibility of dietary fat, were also noted in studies on ruminants (Mirzaei et al. 2012, Hassan and Abdel-Raheem 2013, Wang and Wang 2016) in which analogical herbal mixtures were applied.

No effect of the herbal treatment was found in either crude fibre (CF) or nitrogen-free extracts (NFE) digestibility throughout the experimental period. This result is consistent with the previous findings described by Castillejos et al. (2006), Hosoda et al. (2006) and Wanapat et al. (2008, 2013), who reported that nutrient digestibility did not change when animals were supplemented with plant herbs. Contrary to these results, other authors (Benchaar et al. 2006, Hassan and Abdel-Raheem 2013, Wang and Wang 2016) reported improved crude fibre digestibility. Herbal additives rich in essential oils or pure essential oils supplemented in ruminant rations may stimulate cellulose-degrading bacteria; thus, increased crude fibre digestibility is observed (Benchaar et al. 2006). Naturally, the major impact on nutrient digestibility is exerted by the composition of herbs supplemented in feed rations. However, the contrasting results between various studies may reflect the basic differences in the feed ration composition, especially the content of structural and non-structural carbohydrates.

An increasing trend in nutrient digestibility, particularly crude protein and fat, was observed along with the growth of animals. The differences obtained in the experimental group of animals with enhanced protein utilization seem to have quite small values. However, when applied to highly productive animal herds, they become relevant.

CONCLUSIONS

Based on the results of the study, at least a 3% addition of herbal mixture containing Echinacea, garlic, thyme, caraway, and liquorice can be recommended in beef cattle diet in order to improve the utilization of nutrients of the diet. The addition of herbs improves animals' performance. Higher daily gains in the experimental group of animals, with simultaneous better utilization of feed per 1 kg of body weight gain, were found.

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REFERENCES

AOAC International, 2012: Official Methods of Analysis of AOAC International. 19th Edition. Gaithersburg, MD (USA).

BENCHAAR C., PETIT H.V., BERTHIAUME R., WHYTE T.D., CHOUINARD P.Y., 2006: Effects of dietary addition of essential oils and monensin premix on digestion, ruminal fermentation characteristics milk production, and milk composition in dairy cows. J. Dairy Sci. 89: 4352–4364.

BUSQUET M., CALSAMIGLIA S., FERRET A., CARRO M.D., KAMEL C., 2005: Effect of garlic oil and four of its compounds on rumen microbial fermentation. J. Dairy Sci. 88: 4393–4404.

CASTILLO A.R., KEBREAB E., BEEVER D.E., FRANCE J., 2000: A review of efficiency of nitrogen utilization in lactating dairy cows and its relationship with environmental pollution. J. Anim. Feed Sci. 9: 1–32.

CASTILLEJOS L., CALSAMIGLIA S., FERRET A., 2006: Effect of essential oil active compounds on rumen microbial fermentation and nutrient flow in in vitro systems. J. Dairy Sci. 89: 2649–2658.

HASSAN E.H., ABDEL-RAHEEM S.M., 2013: Response of Growing Buffalo Calves to Dietary Supplementation of Caraway and Garlic as Natural Additives. World Appl. Sci. J. 22 (3): 408–414.

HOSODA K., MATSUYAMA H., PARK W.Y., NISHIDA T., ISHIDA M., 2006: Supplementary effect of peppermint (*Mentha piperita*) on dry matter intake, digestibility, ruminal fermentation and milk production in early lactating dairy cows. Anim. Sci. J. 77: 503–509.

IVAN M., NEILL L., FORSTER R., ALIMON R., RODE L.M., ENTZ T., 2000: Effects of Isotricha, Dasytricha, Entodinium and total fauna on ruminal fermentation and duodenal flow in wethers fed different diets. J. Dairy Sci. 83: 776–787.

KLEBANIUK R., 2011: Zioła i wyciągi ziołowe. In: Chemia i biotechnologia w produkcji zwierzęcej. PWRiL, Warszawa: 131–139.

KLEBANIUK R., GRELA E., KOWALCZUK-VASILEV E., FLOREK M., GÓŹDŹ J., PECKA S., DANEK-MAJEWSKA A., 2012: Wpływ ekologicznych dodatków ziołowych w żywieniu zwierząt w tym ryb, na ich zdrowotność z uwzględnieniem efektów produkcyjnych. Wyniki badań z zakresu rolnictwa ekologicznego w 2011 roku. Wyd. MRiRW, Warszawa – Falenty: 139–149.

KLEBANIUK R., GRELA E.R., KOWALCZUK-VASILEV E., FLOREK M., GÓŹDŹ J., PECKA S., 2011: Ochrona zdrowia zwierząt. Wpływ ekologicznych dodatków ziołowych w żywieniu zwierząt na ich zdrowotność. Sprawozdanie z prowadzenia w 2011 r. badań na rzecz rolnictwa ekologicznego tematu realizowanego przez Instytut Żywienia Zwierząt i Bromatologii Uniwersytetu Przyrodniczego w Lublinie. Retrieved from

http://www.biologia.up.lublin.pl/upload/06_01_04_Sprawozdanie 2011.pdf.
KLEBANIUK R., GRELA E.R., KOWALCZUK-VASILEV E., FLOREK M., GÓŹDŹ J., PECKA S., DANEK-MAJEWSKA A., 2013: Wpływ ekologicznych dodatków ziołowych w żywieniu zwierząt na ich zdrowotność. Wyniki badań z zakresu rolnictwa ekologicznego w 2012 roku. Wyd. MRiRW, Warszawa – Falenty: 31–41.
KRUSIŃSKI R., GRUSZECKI T.M., GRELA E.R., 2004: Zastosowanie mieszanki ziołowej w tuczu jagniąt. Roczn. Nauk. Zoot., Suppl. 20: 43–46.
ŁOZICKI A., DYMNICKA M., 2001: Porównanie wyników odchowu cieląt rasy hereford w wybranych gospodarstwach na terenie Polski [Comparison of results of Hereford race calves breeding on selected farms in Poland]. Ann. Warsaw Univ. Life Sci.-SGGW, Anim. Sci., special number: 334–341.
ŁOZICKI A., DYMNICKA M., SOUKUP T., 2006: Preparaty ziołowe w żywieniu krów mlecznych. Bydło 11: 16–19.
MIRZAEI F., PRASAD S., SAVAR SOFLA S., 2012: Influence of Medicinal Plants Mixture on Productive Performance Cross Bred Dairy Goats. Curr. Res. Dairy Sci. 4 (1): 6–16.
PATRA A.K., SAXENA J., 2010: A new perspective on the use of plant secondary metabolites to inhibit methanogenesis in the rumen. Phytochemistry 71: 1198–1222.
Regulation of the Polish Minister of Agriculture and Rural Development of 2 December 2004 on methods of determining the content of nutrients and feed additives in feedstuffs, premixes, feed mixtures and medical feeds.
ROGULSKI W., 1997: Pobieranie i przygotowanie próbek pasz do analizy chemicznej. In: J. Chachułowa, J. Skomiał (Eds). Żywienie zwierząt i paszoznawstwo. Wyd. SGGW, Warszawa: 7–11.
SKOMIAŁ J., 1997: Ocena wydajności pastwisk. In: J. Chachułowa, J. Skomiał, (Eds). Żywienie zwierząt i paszoznawstwo. Wyd. SGGW, Warszawa, 83–86.
SRINIVASAN K., 2005: Spices as influencers of body metabolism: An overview of three decades of research. Food Res. Int. 38: 77–86.
STRZETELSKI J.A., BRZÓSKA F., KOWALSKI Z.M., OSIĘGŁOWSKI S., 2014: Zalecenia żywieniowe dla przeżuwaczy i tabele wartości pokarmowej pasz. Kraków – IZ-Balice.
WANAPAT M., KHEJORNSART P., PAKDEE P., WANAPAT S., 2008: Effect of supplementation of garlic powder on rumen ecology and digestibility of nutrients in ruminants. J. Sci. Food Agric. 88 (13): 2231–2237.
WANAPAT M., KANG S., KHEJORNSART P., WANAPAT S., 2013: Effects of Plant Herb Combination Supplementation on Rumen Fermentation and Nutrient Digestibility in Beef Cattle. Asian-Australas. J. Anim. Sci. 26 (8): 1127–1136.
WANG S.P. , WANG W.J., 2016: Effects of dietary supplementation of Chinese herb medicine mixture on rumen fermentation, nutrient digestion and blood profile in goats. S. Afr. J. Anim. Sci. 46 (3): 247–260.
WINNICKI S., JUGOWAR J., NAWROCKI L., KALIKA G., RUDOWICZ-NAWROCKA J., 2012: System TMR żywienia krów mlecznych w aspekcie zasad rolnictwa precyzyjnego. Probl. Inż. Rol. 1–3, 1 (750: 77–85.

Streszczenie: *Wpływ mieszanki ziołowej w dawkach bydła mięsnego na wskaźniki wydajności opasu oraz strawność składników pokarmowych*. Celem badań jest ocena wpływu stosowania mieszanki ziół w dawkach pokarmowych dla opasów na przyrosty masy ciała, zużycie paszy na 1 kg przyrostu masy ciała oraz strawność składników pokarmowych. Badania przeprowadzono na 16 cielętach rasy limousine utrzymywanych od około 100 kg do 650 kg masy ciała. Zwierzęta podzielono na dwie grupy: kontrolną (C) i doświadczalną (E). Zwierzęta obydwu grup otrzymywały w dawce te same pasze objętościowe i mieszan-

kę treściwą. Czynnikiem doświadczalnym była mieszanka suszonych, krojonych ziół (receptura własna): jeżówka (*Echinacea purpurea* Moench), czosnek (*Allium sativum* L.), tymianek (*Thymus vulgaris*), kminek (*Carum carvi*), i lukrecja (*Glycyrrhiza glabra*) dodawana do dawki w ilości 3% przewidywanego dziennego pobrania suchej masy dawki. W trakcie badań oceniono spożycie paszy, przyrost masy ciała zwierząt, zużycie paszy na 1 kg masy ciała przyrostu oraz strawność składników odżywczych. Badanie strawności przeprowadzono metodą wskaźnikową przy wykorzystaniu popiołu nierozpuszczalnego w HCl (AIA). Dodatek ziół do dawek pokarmowych poprawił wskaźniki odchowu bydła. U zwierząt grupy eksperymentalnej obserwowano większe dzienne przyrosty masy ciała (1194 g na głowę dziennie), w odniesieniu do tych żywionych bez dodatku ziół (982 g na głowę dziennie), przy jednoczesnym mniejszym średnim zużyciu paszy treściwej na 1 kg przyrostu masy ciała (5,01 kg w grupie eksperymentalnej; 5,94 kg w grupie kontrolnej). Większe wartości współczynników strawności pozornej białka i tłuszczu odnotowano w grupie zwierząt otrzymujących zioła (odpowiednio o 1,3 oraz 2,5 punktu procentowego), w porównaniu do zwierząt grupy kontrolnej. Podsumowując, co najmniej 3% dodatek mieszanki ziołowej zawierającej jeżówkę, czosnek, tymianek, kminek i lukrecję może być zalecany w celu poprawy wskaźników odchowu bydła mięsnego. Dodatek ziół poprawia wydajność zwierząt. W grupie zwierząt doświadczalnych stwierdzono większe dzienne przyrosty zwierząt, z jednoczesnym lepszym wykorzystaniem paszy na 1 kg przyrostu masy ciała.

Słowa kluczowe: bydło mięsne, zioła, strawność, wskaźniki odchowu

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