ISSN 0370-0291, UDC 63

ACS

CROATIA

AGRICULTURAE CONSPECTUS SCIENTIFICUS

POLJOPRIVREDNA ZNANSTVENA SMOTRA

VOLUMEN 63 BROJ 1-2 1998

http://www.agr.hr/smotra/

Mineral Composition of Liver and Kidneys in Alpine and Saanen Kids

B. MIOČ
VESNA PAVIĆ
M. KAPŠ

SUMMARY

Examination of mineral composition of liver and kidneys was conducted on 27 kids (13 Alpine and 14 Saanen) wich were kept under the same zootechnical conditions. Kids were slaughtered when 78 days old (average 16 kg body weight). Samples of liver and kidneys were taken individually from each kid and were weighed, homogenized and frozen. Concentration of calcium (Ca), phosphorous (P), potassium (K), magnesium (Mg), sodium (Na), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) was determined by atomic absorption on AAS PU - 9100X. Concentration of all examined minerals found in liver for both breeds was higher than in kidneys. Among all the minerals in both liver and kidneys K showed the highest concentration while Fe and Cu the lowest one. The influence of breed was found significant ($P<0.05$) only for the concentration of P. Positive and significant ($P<0.01$) correlations were found for the concentration of Ca, P and Zn between liver and kidneys.

KEY WORDS

Alpine, liver, kidneys, kids, minerals, Saanen

Department of Animal Production
Faculty of Agriculture Universitiy of Zagreb
Svetošimunska 25, 10000 Zagreb, Croatia
Received: March 25, 1998

Mineralne tvari u jetri i bubrezima alpina i sanske jaradi

B. MIOČ
VESNA PAVIĆ
M. KAPŠ

SAŽETAK

Istraživanje sadržaja makro (Ca, P, K, Mg, Na) i mikro elemenata (Fe, Mn, Zn, Cu) izvršeno je na uzorcima jetre i bubrega mlade jaradi. Ukupno 27 muške jaradi alpina i sanske pasmine (13 alpske i 14 sanske), tijekom cijelog tova bilo je u istim uvjetima držanja, njege i osobito hranidbe. Prosječna tjelesna masa jaradi neposredno prije klanja (78 dan) iznosila je 16 kg. Pri klanju su od svakog jareta pojedinačno uzeti bubrezi i jetra, koje smo izvagali, a nakon toga homogenizirani i zamrznuli. Koncentracija kalcija (Ca), fosfora (P), kalija (K), magnezija (Mg), željeza (Fe), mangana (Mn), cinka (Zn), bakra (Cu) i natrija (Na) određena je atomskom absorpcijom na Acsu PU-920. U obje pasmine koncentracije svih istraživanih mineralnih tvari bile su veće u jetri nego u bubrezima. Međutim, signifikantan utjecaj pasmine utvrđen je samo za sadržaj fosfora ($P < 0.05$). Jetra i bubrezi obiju pasmina bili su najbogatiji kalijem, a najsiromašniji željezom i bakrom. Utvrđena je visoka signifikantna koerelacija između koncentracija kalcija, fosfora i cinka u jetri s onima u bubrezima ($P < 0.01$).

KLJUČNE RIJEČI

alpina, bubrezi, jarad, jetra, mineralni sastojci, sanska.

Zavod za specijalno stočarstvo
Zavod za opće stočarstvo
Agronomski fakultet Sveučilišta u Zagrebu
Svetošimunska 25, 10000 Zagreb, Hrvatska
Primljeno: 25. ožujka 1998.

INTRODUCTION

All forms of living matter require inorganic elements, or minerals, for their normal life processes. Animal tissues and all feeds contain inorganic or mineral elements in widely varying amounts and proportions. Some tissues, e.g. liver, kidneys, bones, blood and hair are very sensitive to changes in mineral composition of feed, but are also influenced by some external factors (Niinivaara and Antila, l972; Ammerman et al., 1974; Underwud, 1977). On the other hand, muscles are not that much affected by that same factors.

Meat is a very important source of minerals in human nutrition and they are in forms that are much more mobile and accessible to the humans, than the minerals of non-animal origin (Doorenbal and Murray, 1981; Marchello et. al., 1985). Mineral composition of meat is influenced by animal species breed, feed, climate and type of tissue and muscles. Concentration of specific minerals varies in some muscles of cattle (Marchello et. al., 1985; Kotula and Lusby, 1982) and is directly related to their physiological function. Dark muscles are richer than white muscles (Wagner et. al., 1976) on the essential minerals (Na, Mn, Cu, Fe and Zn). The influence of sex is weak (Zarkadas et. al., 1987), while breed significantly influences the concentrations of Na and K (Gillett et al., 1965). Type of tissue and muscle have more influence on the concentration of macroelements in goat meat than breed and sex (Park-Young, 1990). Concentration of some minerals in liver is often a good indicator of their true availability in the organism, e.i. a "mirror" of nutrition and metabolism.

The aim of the present study was to examine the mineral composition of liver and kidneys in young kids, the influence of breed and type of tissue on concentrations of minerals and some trace elements. The minerals included in the study include calcium (Ca), phosphorous (P), potassium (K), magnesium (Mg), sodium (Na), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu).

MATERIALS AND METHODS

Right after the birth, 27 male kids (13 Alpine and 14 Saanen) were separated from their mothers and kept under the same housing and nutritional conditions till the day of slaughter. After they sucked a colostrum, kids were given a milk replacer. After two weeks of age they were offered a good quality hay and pelleted feed. All the kids were slaughtered at the when 78 days old. Samples of liver and kidneys were taken from each kid and after the separation of fat by hand the samples were weighed, homogenised and frozen and the chemical analyses were done.

The concentration of Ca, P, K, Mg, Na, Fe, Zn, Mn and Cu in mg/100 g of wet sample, was determined by atomic absorption on PU-9100X AAS.

Minerals (Ca and Mg) and trace elements (Mn, Zn, Cu and Fe) were analysed by the flame atomic absorption spectrometry by injecting the solution of burned sample in to the flame of air - acetylene mixture and by increasing sensibility adding the slotted tube atom trap. K and Na were analised by flame photometry according to Labge. P was analised by spectrometry (620 mm-complex blue colour of heteropoled phosphomolybdenic acid) digestion or destruction of sample by wet burning procedure.

Breed influence on the concentration of minerals in liver and kidneys in Alpine and Saanen kids was analysed according to GLM of SAS/STAT, 1990 procedure.

RESULTS AND DISCUSSION

The concentration of all examined minerals was higher in liver than in kidneys for both breeds (Table 1.). Similar results were reported on cattle (Stadish et al., 1969; Dorn et al., 1973; Stabel-Taucher et al., 1975), sheep (Doyle and Pfander, 1975), swine (Hedges and Kornegay, 1973; Gipp et al. 1974) and poultry (Freland and Cousins, 1973). The results obtained in the present study showed K and Na, had higher concentration than P and Ca concentration, and Mg had the lowest concentration of all minerals. As for the trace elements, Zn has the highest concentration, while Cu had the lowest concentration (Table 1.). The liver and kidneys of Alpine breed kids contained more Ca, P, Mg, Na and Zn and less K, Fe and Cn than those of Saanen breed, but the differences were significant ($P<0.05$) only for the concentration of P. In comparison with liver mineral concentration of adult goats, where a breed also has no major influence (Park, 1990), kids have less P and Mg and more K, Ca and Na.

In the present study liver and kidneys of kids had the lower concentration of trace elements (Fe, Zn and Cu) compared to different cattle breeds (Littledike et al., 1995), sheep (Watson et al., 1973; Fick et al., 1976), pigs (Hedges and Kornegay, 1973, Owen et al., 1973) and poultry (Freeland and Cousins, 1973; Kienholz et al., 1974). Concentration of some minerals in liver is often a good indicator of their availability in the whole organism. Liver Cu is generally believed to be the best indicator of the Cu status of the animal (Puls, 1990). Breeds of lambs with the highest liver Cu concentrations had the highest biliary Cu concentrations (Littledike and Young, 1993).

Table 1. Mineral concentration oi liver and kidneys in Alpine and Saanen kids in mg/100g wet weight

Breed	Alpine				Saanen			
n	13				14			
	Liver		Kidneys		Liver		Kidneys	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Ca	20.39	1.25	11.38	1.13	16.69	1.89	10.35	0.72
P	31.15[a]	0.78	23.29	0.43	28.73[b]	0.67	20.79	0.45
K	324.28	12.71	237.99	3.16	342.27	15.67	244.33	4.99
Mg	11.81	0.64	7.20	0.17	10.45	0.55	7.06	0.23
Na	298.00	8.13	195.15	1.89	287.58	14.74	206.05	4.56
Zn	3.44	0.53	1.89	0.09	1.81	0.16	1.34	0.12
Mn	1.738	0.08	0.144	0.01	1.897	0.13	0.140	0.01
Cu	1.74	0.16	0.54	0.07	2.34	0.25	0.66	0.09
Fe	0.718	0.05	0.466	0.03	0.753	0.03	0.442	0.02

a:b P<0.05

Table 2. Correlations between mineral concentration of liver and kidneys

				Alpine Liver					
Kidney	Ca	P	K	Mg	Fe	Zn	Mn	Cu	Na
Ca	0.55*								
P	-0.15	0.44*							
K	-0.09	-0.37	0.43*						
Mg	0.23	-0.11	-0.48	0.002					
Fe	-0.03	-0.20	-0.72**	0.06	-0.49				
Zn	0.47	-0.12	-0.41	0.27	-0.35	0.38			
Mn	-0.002	-0.32	-0.51	0.02	-0.36	0.52	-0.04		
Cu	-0.05	0.55*	-0.19	0.18	-0.26	0.06	-0.51	0.14	
Na	-0.04	0.05	-0.27	0.23	0.02	-0.37	-0.19	0.28	0.49
				Saanen					
Ca	0.87**								
P	-0.28	0.51*							
K	0.47	0.06	0.14						
Mg	0.52*	-0.06	-0.42	0.53*					
Fe	0.20	0.06	-0.005	0.21	0.53*				
Zn	0.49	-0.04	0.26	0.02	0.17	0.49*			
Mn	0.31	0.01	0.12	0.02	0.54*	0.11	0.25		
Cu	0.59*	0.12	0.33	0.81**	0.44	0.09	0.10	-0.05	
Na	-0.07	-0.27	-0.63**	-0.02	0.28	-0.30	-0.22	0.02	-0.23

* (P<0.05) ** (P<0.01)

Correlations among mineral concentration in liver and kidneys

Signifikant and positive correlations (P<0.05) were found between the concentration of Ca and P in liver and kidneys of Alpine kids. In Saanen breed (Table 2.) positive and significant correlations were found for Ca (P<0.01), P, Mg, Fe and Zn (P<0.05).

For the content of Mg, Fe and Zn (P<0.05) in Alpine kids the significant positive correlations were found between liver and kidneys. In addition, positive significant correlations (P<0.05) were found between Ca in liver and Cu in kidneys of Saanen kids, while very low and negative correlations was found in Alpine kids. Negative significant correlations (P<0.01) were found between Na in kidneys and liver of K for the Saanen kids.

Correlations between the mineral concentration within a tissue

Correlations were not significant, exept for Na and Cu (P<0.05) which were found between the concentration of analysed minerals in liver of Alpine

kids (Table 3.). However, correlations between Na and P, and between Ca and Zn measured in the liver of Saanen kids were significant (P<0.01), what is in accordance with the results for sheep (Langlands et al., 1987) and cattle (Littledike et al., 1995). At the same time, negative and significant correlations were estimated between K and Zn (P<0.01) for Alpine breed, and between Fe and Cu in both breeds respectively (P<0.05).

High positive correlations were found among Ca and Mg and Zn (P<0.01). Positive correlations found among the concentration of P and Na in liver of Saanen kids is similar to the results reported for adult goats (Park, 1990). Positive significant correlations were found in kidneys of Alpine kids between Ca and Zn and between Zn and Mn (P<0.05). Also positive significant correlations (P<0.05) were also noticed between Fe and Zn, and Fe and Mn.

Table 3. Correlations between mineral concentration of liver

				Alpine Liver				
	Ca	**P**	**K**	**Mg**	**Fe**	**Zn**	**Mn**	**Cu**
P	0.11							
K	-0.13	-0.03						
Mg	0.18	0.37	-0.12					
Fe	-0.18	0.03	0.47	0.21				
Zn	-0.17	0.05	-0.72**	-0.03	-0.28			
Mn	-0.11	0.24	0.13	-0.10	0.15	0.05		
Cu	0.06	0.02	-0.46	-0.11	-0.62*	0.49	-0.08	
Na	-0.33	-0.18	0.10	0.29	-0.45	-0.06	-0.10	0.61*
				Saanen				
P	0.20							
K	0.22	0.57*						
Mg	0.66**	0.17	0.17					
Fe	0.08	0.23	0.42	0.22				
Zn	0.66**	-0.07	0.01	0.28	-0.38			
Mn	0.08	0.42	0.53*	-0.09	0.47	0.03		
Cu	-0.08	-0.58*	-0.37	0.001	-0.46*	0.16	-0.79**	
Na	0.12	0.65**	0.45	0.27	0.32	0.16	0.26	0.14

* (P<0.05) ** (P<0.01)

Table 4. Correlations of mineral concentration in kidneys

				Alpine Kidneys				
	Ca	**P**	**K**	**Mg**	**Fe**	**Zn**	**Mn**	**Cu**
P	-0.05							
K	0.38	0.13						
Mg	0.36	-0.21	0.04					
Fe	0.25	0.07	-0.06	0.12				
Zn	0.70**	-0.06	0.15	0.19	0.60*			
Mn	0.41	-0.41	0.06	0.30	0.62*	0.71**		
Cu	-0.08	0.21	-0.48	-0.12	0.21	0.05	-0.17	
Na	-0.19	0.28	-0.19	-0.37	-0.25	-0.45	-0.70*	0.23
				Saanen				
P	0.41							
K	0.58*	-0.20						
Mg	0.62**	-0.01	0.24					
Fe	0.34	0.06	0.48	0.53*				
Zn	0.34	-0.29	0.60*	0.23	0.33			
Mn	0.27	0.01	0.56*	0.46	0.81**	0.70**		
Cu	0.62**	-0.44	0.35	0.28	0.38	0.05	0.18	
Na	0.10	0.08	0.27	0.44	0.52	-0.01	0.40	0.14

* (P<0.05) ** (P<0.01)

CONCLUSIONS

Mineral concentration in liver than in kidneys of all the examined minerals were found for both Alpine and Saanen breeds. In both kidneys and liver, K and Na were found to have higher concentration then the other minerals, while among trace elements, the highest concentration was for Zn. There was no significant difference between Alpine and Saanen breeds neither in minerals nor in trace elements, except for P ($P<0.05$). Positive correlations in mineral and trace element concentrations between liver and kidneys were found for Ca, P and K in Alpine kids ($P<0.05$), and for Ca ($P<0.01$), P, Mg, Fe and Zn ($P<0.05$) for Saanen kids.

REFERENCES

Ammerman, C.B., Loaiza, J.M., Blue, W.G., Gamble, J. F. and Martin, F. G., 1974. Mineral composition of tissues from beef cattle under grazing conditions in Panama, J Animal Sci., 38, 158-162.

Doorenbal, H., and Murray, A.C., 1981. Effect of age, breed, sex and muscle on certain mineral concentrations in cattle. J. Food Sci., 47:55.

Dorn C.R., Pierce II, J.O., Chase, G. R., Philips, P.E., 1973. Cadmium, copper, lead and zinc in blood, milk, muscle and other tissues of cattle from an area of multiple-source contamination. Trace Substances in Environ. Health VII: 191, Univ. Ml. Press.

Doyle, J.J., Pfander, W.H., 1975. Interactions of cadmium with copper, iron, zinc and manganese in ovine tissu. J. Nutr. 105: 599.

Fick, K.R., C.B. Ammerman, S.M. Miller, G.F. Simpson and P.F. Loggins., 1976. Effect of dietary lead on performance, tissue mineral composition and lead absorption in sheeo. J. Anim. Sci. 42:515.

Freeland, J.H., Cousins, R.J., 1973. Effect of dietary cadmium on anemia, iron absorption, and cadmium binding protein in the chick. Nutrition Reports International 8 (5) 337-347.

Gillett, T.A., Pearson, A.M., and Kirton, A.H., 1965. Variation in Potassium and Sodium in Muscles of the Pig. J. Anim. Sci. 24: 177-181.

Gipp. W.F., Pond, W.G., Kallfelz, F.A., Tasker, J.B., Campen, D.R.Van., Krook, L., Visek, W.J., 1974. Effect of dietary cooper, iron and ascorbic acid concentration on hematology, blood and tissue cooper, iron and zinc concentrations and 64Cu and 59Fe metabolism in young pigs. J. of Nutrition 104 (5) 532-541.

Hedges, J.D., Kornegay, E.T., 1973. Interrelationship of dietary copper and iron as measured by blood parameters, tissue stores and feedlot performance of swine. J. of Anim. Sci 37 (5) 1147-1154.

Kienholz, E.W., W.R. Chappell, R.R. Megan and H.Rudolph., 1974. Effects of dietary supplements of copper sulfate and molybdate upon liver and kidney concentrations of ten minerals in young chickens. Trace Subs. in Environ. Health 8:373.

Kotula, A.W. and Lusby, W.R., 1982. Mineral composition of muscles of 1-to 6-year old steers. J. Anim. Sci. 54 (3): 544.

Langlands, J.P., G.E. Donald, and A. J. Smith., 1987. Analysis of data collected in a residue survey: Copper and zinc concentrations in liver, kidney and muscule in Austrelian sheep and cattle. Aust. J. Exp. Agric. 27:485.

Littledike. E.T., and L.D. Young., 1993. Efect of sire and dam breed on copper status of fat lambs. J. Anim. Sci. 71:774.

Littledike, T.E. Wittum, and Jenkins T.G., 1995. Effect of Breed, Intake, and Carcass Composition on the Status of Several Macro and Trace Minerals of Adult Beef Cattle. J. Anim. Sci. 73: 2113-2119.

Marchello, M.H., Slanger, W.D., and Milne, D.G., 1985. Macro and micro minerals from selected muscles of pork. J. Food Sci. 0: 1375.

Niinivaara, F. P. and Antila, P., 1972. Der nahrwert des pleisches. Fleischforschung und prayis schriftenreihe, Heft 8, pp. 181. Rheinhessischen Druckwestate, Alzey.

Owen, A.A., E. R. Peo, D.J. Cunningham and B.D. Mosen., 1973. Effect of EDTA on utilization of dietary zinc by G.F. Swine. J.Anim. Sci. 37:470.

Park-Young W., 1990. Effect of breed, sex and tissues on concentrations of macrominerals in goat meat. J. of Food Sci. 55 (2) 308-311.

Puls, R., 1990. Mineral Levels in Animal Health, Diagnostic Data. p 71. Sherpa International, Clearbrook, British Columbia, Canada.

SAS. 1990. SAS/ STAT User's Guide (Release 6.03). SAS Inst. INC., Cary, NC.

Stabel-Taucher, R., Nurmi, E., Karppanen, E., 1975. Concentration of copper, zinc, lead, cadmium and mercury in muscle, liver and kidney of Finnish cattle. J. of the Scientific Agric. Soc. of Finland 47 (6) 469-479.

Standish, J.F., Ammerman, C.B., Simpson, C.F., Neal, F.C., and Palmer A.Z., 1969. Influence of graded levels of dietary iron, as ferrous sulfate, on performance and tissue mineral composition of steers. J. Anim. Sci. 29: 496.

Underwood, E.J., 1977. Trace elements in human and animal nutrition, 4th ed. Academic Press, New York.

Wagner, K. H., Saracan, C., Ali, A., and Wagner-Hering, E., 1976. A contribution to the distribution of minerals and amino acids in light and dark pork. Die Fleischwirschaft 56: 1651.

Watson, L.T., C.B. Ammerman, J.P. Fester and C.E.Roessler., 1973. Influence of manganese intake on metabolism of manganese and other minerals in sheep. J. Anim. Sci. 36:131.

Zakaradas, C.G., Marshall, W.D., Khalili, A.D., Nguyen, Q., Zakaradas, G.C., Karatzas, C.N., and Khanizadeh., 1987. Mineral Composition of Selected Bovine, Porcine and Avian Muscles, and Meat Products. J. of Food Sci. 52 (3) 520-525.