

Comparison of Macro and Micro Mineral Compositions of Some Alternative Protein Sources Used in Livestock with Respect of Fish Diets Requirements in Turkey

Emrah KAYA^{1*}, Adem KAMALAK¹, Ali İhsan ATALAY², Özer KURT¹

¹KSU, Faculty of Agriculture, Department of Animal Science, Kahramanmaraş/Turkey
²Iğdır University, Faculty of Agriculture, Department of Animal Science, Iğdır/Turkey

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ABSTRACT: The aim of this study was to compare the macro and micro mineral composition of some protein sources used in livestock production in Turkey. There are significant ($P<0.001$) variations among protein sources. The legume grain sources had a significant ($P<0.001$) effect on the macro and micro mineral contents. The calcium (Ca) content of *L. Sativus* was significantly ($P<0.001$) higher than those of legume seeds and soybean meal (SBM). On the other hand phosphorus (P), magnesium (Mg) and potassium (K) contents of legume grains was significantly lower than that of SBM. The zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) contents of legume seeds were significantly lower than that of SBM. Grains from *Vicia pregrina*, *Pisum elatius* and *Vicia narbonensis* are deficient in calcium to meet requirement of catfish and tilapia for optimum growth. *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* should be supplemented with calcium to meet the requirement for optimum growth of fish. The legume grains studied in the current experiment are deficient in phosphorus to meet requirement of catfish, rainbow trout, common carp and tilapia for optimum growth whereas legume grains are sufficient in magnesium and zinc to meet requirement of catfish, rainbow trout, common carp and tilapia for optimum growth. On the other hand the legume grains studied in the current experiment are sufficient in iron to meet requirement of catfish and rainbow trout for optimum growth whereas *Latirus sativus*, *Vicia pregrina* and *Pisum elatius* are deficient in iron to meet requirement of common carp. The legume grains studied in the current experiment are sufficient in manganese to meet requirement of catfish whereas the legume grains are insufficient in manganese to meet requirement of rainbow trout and common carp. Although *Vicia narbonensis* are sufficient in copper to meet requirement of catfish, rainbow trout, common carp, *Vicia peregrina* and *Pisum elatius* are insufficient in copper to meet requirement of catfish, rainbow trout and common carp. As a conclusion, grains from *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* used as a alternative protein sources in fish diets should be supplemented with minerals which are deficient to obtain the optimum performance from fish.

Key Words: Fish, legume grain, macro minerals, micro minerals

Türkiye’de Hayvan Beslemede Kullanılan Bazı Alternatif Protein Kaynaklarının Balıkların Besin Madde Gereksinimi Baz Alınarak Makro ve Mikro Mineral İçeriklerinin Karşılaştırılması

ÖZET: Bu çalışmanın amacı, Türkiye’de hayvan beslemede kullanılan alternatif protein kaynaklarının makro ve mikro mineral içeriklerini karşılaştırmaktır. Protein kaynakları arasında mineral madde bakımından önemli varyasyonlar mevcuttur. Baklagil çeşidi, danelerin makro ve mikro element içeriklerini önemli derecede etkilemiştir. Mürdümüğün (*Lathyrus sativus*), kalsiyum (Ca) içeriğinin diğer baklagil daneleri ve soya küspesinin kalsiyum içeriğinden daha yüksek olduğu bulunmuştur. Diğer taraftan, baklagil tohumlarının fosfor (P), magnezyum (Mg) ve potasyum (K) içerikleri soya küspesinden daha düşük bulunmuştur. Baklagil tohumlarının çinko (Zn), demir (Fe), manganez (Mn) ve bakır (Cu) içerikleri de soya küspesinden daha düşük bulunmuştur. Culban (*Vicia pregrina*), yabani bezelye (*Pisum elatius*) ve koca fiğ (*Vicia narbonensis*) tohumları kalsiyum içeriği bakımından yayın balığı ve tilapiaların optimum büyümeleri için yeterli değildirler. Bu yüzden, culban (*Vicia pregrina*), yabani bezelye (*Pisum elatius*) ve koca fiğ (*Vicia narbonensis*) tohumları kalsiyum bakımından desteklenmelidir. Bu çalışmada kullanılan baklagil daneleri fosfor içeriği bakımından yayın balığı, gökkuşuğu alabalığı, pullu sazan ve tilapiaların optimum büyümesi için yeterli olmamasına rağmen, baklagil daneleri magnezyum ve çinko bakımından yayın balığı, gökkuşuğu alabalığı, pullu sazan ve tilapia balıklarının optimum büyümesi için yeterlidir. Diğer taraftan bu çalışmada kullanılan baklagil daneleri demir bakımından yayın balığı ve gökkuşuğu alabalıklarının optimum büyümeleri için yeterli olmasına rağmen mürdümük, culban ve yabani bezelye pullu sazan balıklarının ihtiyacını karşılamada yetersizdir. Bu çalışmada kullanılan baklagil daneleri manganez bakımından yayın balıklarının ihtiyacını karşılamada yeterli olmasına rağmen, baklagil daneleri manganez bakımından gökkuşuğu alabalığı ve pullu sazan balıklarının ihtiyaçlarını karşılamada yetersizdir. Koca fiğ yayın balığı, gökkuşuğu alabalığı ve pullu sazan balıklarının bakır ihtiyacını karşılamada yeterli iken, culban ve yabani bezelye yayın balığı, gökkuşuğu alabalığı ve pullu sazan balıklarının bakır ihtiyacını karşılamada yetersizdir. Sonuç olarak, alternatif protein kaynağı olarak kullanılan mürdümük, culban ve koca fiğin balıklarda optimum performans elde etmek için eksik olduğu minerallerce zenginleştirilmesi gereklidir.

Anahtar Kelimeler: Baklagil dane, balık, makro mineral, mikro mineral

INTRODUCTION

It is well known that feedstuffs have important role for fish in providing with energy, protein and mineral for growth. Recently locally available legume grains were used in livestock nutrition to meet their protein and amino acid requirements due to less expensive protein and amino acid sources compared with soybean and fish meal (Karaman et al., 2009; Büyükçapar and Kamalak, 2010a, b; Ozkan et al. 2011). However the mineral content of locally available legume grains was ignored by researches and there is limited research on the macro and micro mineral contents of locally available legume grains such as *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis*. The minerals have important roles in the formation of skeletal structure, electron transfer, regulation of acid-base equilibrium, and osmoregulation. Minerals are also important components of hormones and enzymes, and they activate enzymes (NRC, 1993). The determination of mineral contents of feedstuffs used fish nutrition allow to make more accurate decision in preparation of diets to achieve the optimum performance of fish. Therefore, the aim of this study was to compare the macro and micro mineral contents of *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* seeds used in fish nutrition with respect of some fish requirement.

MATERIAL and METHODS

Protein sources

In the current study, legume grains from *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* were hand harvested from plots established in the experiment units of natural pasture at seeding stage in Kahramanmaraş, Turkey in September, 2007. The grain samples were shade-dried and milled to pass through a 1 mm sieve for subsequent analysis. The commercially available soybean meal obtained from a feed company (Gürdal Feed Company, Kahramanmaraş, Turkey) were used as standard protein sources to compare the protein sources from legume grains. The protein and amino acids content of these legume grains from *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* were previously investigated by Ozkan et al. (2011).

Chemical Analysis

Dry matter (DM) contents of protein sources were determined by drying the samples at 105 °C overnight (AOAC, 1990). Legume grain samples were digested with HNO₃/HClO₄ mixture for P, K, Ca, Mg, Fe, Mn, Zn and Cu (Jones and Case, 1990). The total P was determined by colorimetric vanadomolybophosphoric acid method (Kuo, 1996) and the total concentrations of K, Ca, Mg, Fe, Mn, Zn and Cu were determined using atomic absorption spectrophotometer. The amount of macro and micro mineral contents was expressed as

g/kg DM. All chemical analyses were carried out in duplicate.

Data on macro and micro mineral contents of protein sources were subjected to one way of ANOVA using GLM of SPSS for Windows (2002). Significance between individual means was identified using the Tukey's Multiple Range test. Mean differences were considered significant at P<0.05. Standard errors of means were calculated from the residual mean square in the analysis of variance. As a complement of ANOVA procedure, principal components analysis (PCA) was performed using mineral composition as variables and legume grains as classification criterion. The PCA analysis allows detection of the degree of association between variables by means of their relative position in a multivariate space, which is reduced to orthogonal directions of maximum variance in the original data (Afifi and Clark, 1996). The biplot display proposed by Gabriel (1971) was used. Data were analyzed using the SYSTAT 10 statistical software.

RESULTS and DISCUSSION

The macro mineral compositions of legume grains and soybean meal used in livestock production in Turkey are presented in Table 1. The Ca content of *Lathyrus sativus* was significantly (P<0.001) higher than those of legume seeds and SBM. On the other hand P, Mg and K contents of legume grains was significantly lower than that of SBM.

Although calcium and phosphorus are directly involved in the development and maintenance of skeletal system and participate in several physiological processes, the dietary supply of phosphate is more critical than that of calcium since fish must effectively absorb, store, mobilize, and conserve phosphate in both freshwater and sea water environments (NRC, 1993). Grains from *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* are deficient in calcium to meet requirement of catfish and tilapia for optimum growth since catfish and tilapia reared in calcium free water require 0.45 percent and 0.7 percent in diet respectively, for optimum growth (Robinson et al., 1986, 1987). *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* should be supplemented with calcium to meet the requirement for optimum growth of fish.

The legume grains studied in the current experiment are deficient in phosphorus to meet requirement of catfish, rainbow trout, common carp and tilapia for optimum growth since catfish, rainbow trout, common carp and tilapia require 0.45, 0.6, 0.6 and 0.5 percent of phosphorus in diet. It is well known that deficiency of phosphorus will result in poor growth, low feed efficiency and poor bone mineralization in most fish (NRC, 1993). Therefore grains from *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* should be supplemented with phosphorus to meet the requirement for optimum growth of fish.

Table 1. The macro mineral compositions of legume grains and soybean meal used livestock nutrition in Turkey

Macro (%)	Sources					SEM	Sig.
	<i>L.sativus</i>	<i>V. pregrina</i>	<i>P. elatius</i>	<i>V. narbonensis</i>	SBM		
Ca	0.069 ^a	0.025 ^{bc}	0.022 ^c	0.024 ^{bc}	0.031 ^b	0.0212	***
P	0.354 ^{bc}	0.268 ^c	0.434 ^b	0.369 ^b	0.762 ^a	0.0277	***
Mg	0.099 ^b	0.085 ^c	0.088 ^c	0.086 ^c	0.155 ^a	0.0022	***
K	1.019 ^c	0.914 ^d	1.265 ^b	1.277 ^b	2.855 ^a	0.0109	***

^{a b c} Row means with common superscripts do not differ ($P > 0.05$); SEM - Standard error mean; Sig. - significance level, SBM - Soybean meal, *** $P < 0.001$.

It is well known that magnesium has role as a cofactor in many enzymatic reactions in intermediary metabolism. Magnesium also plays an important role in respiratory adaptation of freshwater fish (Houston, 1985). However magnesium deficiency may result in anorexia, reduced growth, lethargy and reduced tissue magnesium content in fish (NRC, 1993). The legume grains studied in the current experiment are sufficient in magnesium to meet requirement of catfish, rainbow trout, common carp and tilapia for optimum growth since catfish, rainbow trout, common carp and tilapia require 0.04, 0.05, 0.05 and 0.06 percent of magnesium in diet (NRC, 1993). The legume grains studied in the current experiment are also sufficient in potassium to meet requirement of rainbow trout, pacific salmon for optimum growth since rainbow trout, pacific salmon

require 0.7 and 0.8 percent of potassium in diets (NRC, 1993). However the deficiency sign of potassium is very difficult to produce since fish readily absorb potassium from surrounding aquatic medium.

The micro mineral compositions of legume grains and soybean meal used in livestock production in Turkey are given in Table 2. The Zn, Fe, Mn and Cu contents of legume seeds were significantly lower than that of SBM.

The legume grains studied in the current experiment are sufficient in terms of Zinc to meet requirement of catfish, rainbow trout, common carp and tilapia for optimum growth since catfish, rainbow trout, common carp and tilapia require 20, 30, 30 and 20 mg of Zinc in 1 kg of diets respectively.

Table 2. The micro mineral compositions of legume grains and soybean meal used livestock nutrition in Turkey

Micro (mg/kg DM)	Sources					SEM	Sig.
	<i>L. sativus</i>	<i>V. pregrina</i>	<i>P. elatius</i>	<i>V. narbonensis</i>	SBM		
Zn	26.70 ^d	28.94 ^c	21.45 ^e	31.41 ^b	50.08 ^a	0.4353	***
Fe	76.60 ^d	124.60 ^c	93.85 ^d	175.21 ^b	210.60 ^a	7.2530	***
Mn	7.74 ^b	7.71 ^a	4.43 ^b	7.74 ^b	23.80 ^a	3.5932	**
Cu	4.20 ^c	2.63 ^d	2.62 ^d	7.36 ^b	14.97 ^a	0.0019	***

^{a b c} Row means with common superscripts do not differ ($P > 0.05$); SEM - Standard error mean; Sig. - significance level, SBM - Soybean meal, *** $P < 0.001$.

Iron is an essential element which is found in the body mainly in the complex form bound to proteins such as heme compounds (hemoglobin and myoglobin), heme enzymes (cytochromes, catalase etc). Iron has a role in the cellular respiratory process through its oxidation-reduction activity and electron transfer (NRC, 1993). The legume grains studied in the current experiment are sufficient in terms of iron to meet requirement of catfish and rainbow trout for optimum growth since catfish and rainbow trout require 30 and 60 mg of iron in 1 kg of diets respectively whereas *Laticus sativus*, *Vicia pregrina* and *Pisum elatius* are deficient in iron to meet requirement of common carp since common carp requires 150 mg /kg of diet (NRC, 1993).

The legume grains studied in the current experiment are sufficient in terms of manganese to meet requirement of catfish whereas the legume grains are insufficient in manganese to meet requirement of rainbow trout and common carp since rainbow trout and common carp require 13 mg of manganese in 1 kg diet (NRC, 1993).

Although *Vicia narbonensis* are sufficient in terms of copper to meet requirement of catfish, rainbow trout, common carp, *Vicia peregrina* and *Pisum elatius* are insufficient in copper to meet requirement of catfish, rainbow trout and common carp since catfish, rainbow trout and common carp require 5, 3 and 3 mg copper in 1 kg diet respectively (NRC, 1993).

The analysis of the first two principal components using legume grain classification criterion is given in Figure 1. First two components explained 92.91% of the total variation. The variables P, Mg, K, Zn, Fe, Mn and Cu showed the highest factor loading: -0.929, -0.946, -0.981, .0.969, 0.839, 0.929 and 0.980, respectively, explaining 77.59% of the variability among legume grains through the first component (PC I). The variables Ca showed the highest factor loading: 0.967 explaining 15.326% of the variability among legume grains through the second component (PC II). The principal component analysis allowed better understanding of the complex correlations among the parameters related to macro and micro mineral

composition of legume grains. As can be seen from Figure 1 there is no significant correlation between Ca and other

minerals whereas there is significant correlation among other minerals.

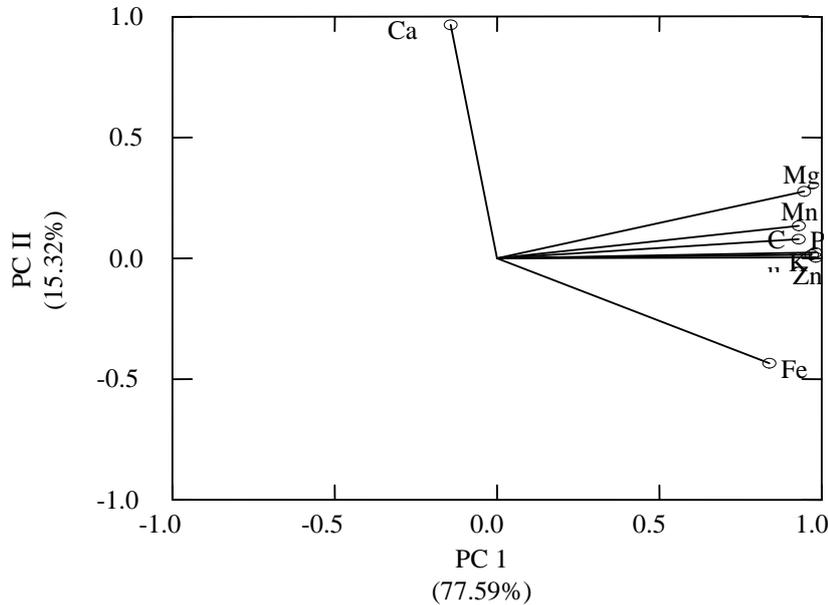


Figure 1. The analysis of the first two principal components using legume grains classification criterion

CONCLUSION

As a conclusion, grains from *Lathyrus sativus*, *Vicia peregrina*, *Pisum elatius* and *Vicia narbonensis* used as alternative protein sources in fish diets should be supplemented with minerals which are deficient to obtain the optimum performance from livestock.

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