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Determination of some anti-nutritional factors and metabolisable energy in acorn (*Quercus branti*), Pistacia atlantica and Pistacia khinjuk seeds as new poultry diets

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ABSTRACT

Samples of acorns, Pistacia atlantica and Pistacia khinjuk seeds from three different climates were used for the determination of apparent and true metabolisable energy and for investigation of the anti-nutritional factors tannin and urease activity. Fifty-five 107-week-old cockerels were used in the experiment. For feedstuffs from each climate, five cockerels in five replications, kept in individual cages, were used. AME, AMEn, TME and TMEn values of the feedstuffs were determined according to Sibbald (1989). The mean value of AMEn for acorn was 14.08, Pistacia atlantica 13.51 and Pistacia khinjuk 17.33 MJ/kg. The tannin content of acorn was 4.7%, Pistacia atlantica 1.43% and Pistacia khinjuk 1.93%, which are considerable for poultry diets. The rate of urease activity in these seeds was very low.
(Keywords: acorn, Pistacia atlantica, Pistacia khinjuk, metabolisable energy, tannin)

ÖSSZEFOGLALÁS

A makk(*Quercus branti*), a Pistacia atlantica és a Pistacia khinjuk mag, mint új baromfitáp komponens metabolizálható energiatartalmának, ill. antinutritív anyagainak meghatározása

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Az Irán 3 különböző klímájú részéből származó makk, Pistacia atlantica és Pistacia khinjuk mag látszólagos, ill. valódi metabolizálható energiatartalmát, valamint antinutritív anyagait (tannin-, ureáz aktivitás) határozták meg, 55, 17 hetes kakassal végzett kísérlet során. Mindegyik klímából származó takarmány esetében 5 kakast 5 ismétlésben állítottak be, melynek során azokat egyéni ketrecekben tartották. A különböző takarmányok AME, AMEn, TME és TMEn értékét Sibbald (1989) módszerével határozták meg. A makk átlagos AMEn tartalma 14,08, míg a Pistacia atlanticaé 13,51, a Pistacia khinjuké pedig 17,33 MJ/kg volt. A makk tannintartalma 4,7%, a Pistacia atlanticaé 1,43%, a Pistacia khinjuké pedig 1,93% volt, mely értékek tekintélyesek a baromfitakarmányként történő felhasználás során. Mindegyik vizsgált esetben az ureáz aktivitás mértéke elhanyagolható volt.
(Kulcsszavak: makk, Pistacia atlantica, Pistacia khinjuk, metabolizálható energia, tannin)

INTRODUCTION

Acorns and wild pistachio (Pistacia atlantica and Pistacia khinjuk) seeds that are provided by the forest are new and unconventional energy sources. Acorn is the fruit of oak trees and wild pistachio seeds are the fruit of the Pistacia species. The oak or Quercus contains 200 species. Four species of oak (*Quercus branti, Quercus infectoria, Quercus libani* and *Quercus petrea*) grow in the Zagrossian region, but Quercus branti is dominant among them (*Sabeti, 1994*). This investigation was carried out on Quercus branti, which is a famed Iranian oak, or the Zagrossian oak, and grows on the Zagros mountain chain in Iran, in an area of about 4 million hectares. This plant grows 650 to 2700 metres above sea level, where the temperature varies between -31°C and +45°C and the rainfall between 250 and 900 mm. Pistacia atlantica and Pistacia khinjuk are two major species that grow in the Zagrossian region with the Quercus species. Pistacia atlantica grows 600 to 3000 metres and Pistacia khinjuk 700 to 1900 metres above sea level (*Sabeti, 1994*).

Acorn contains considerable amounts of tannin and other anti-nutritional substances. Given in large amounts they may be toxic. (Poisoning of cattle has been recorded). Rations with above 25% acorn meal produced eggs with coloured yolks and low hatchability (*De Boer and Bickel, 1988*). Few laboratory analyses have been performed on acorns. Proximate analyses have revealed that the chemical composition of acorn is similar to that of chaffy cereals (*Baumgras, 1944; Wanio and Forbes, 1941;*). *Ofcarcik* and *Burn* (*1971*) have reported the result of a trial on chemical and physical properties of selected acorns in Texas. Acorn varieties within twelve species were analysed for chemical and physical attributes. The kernels were evaluated for moisture, ether extract, crude fibre, ash, crude protein, tannin, nitrogen-free extract (less tannins), texture and surface colour. It was reported total phenolics in acorns from different species of oak trees in conjunction with acorn poisoning.

In accordance with the facts outlined above the objective of this investigation in the first stage was to determine the apparent and true metabolisable energy of acorns, Pistacia atlantica and Pistacia khinjuk seeds and in the second stage to determine the tannin content and urease activity of acorns, Pistacia atlantica and Pistacia khinjuk seeds.

MATERIALS AND METHODS

Nine samples including three diets from three different climates (3 samples of dehulled acorn, 3 samples of Pistacia atlantica and 3 samples of Pistacia khinjuk seeds) were used in the experiments for the determination of apparent and true metabolisable energy. Fifty-five 107-week-old cockerels (Rhode Island Red) were used in the experiment. For every feed from each climate, five cockerels in five replications were used. The cockerels were placed in individual cages with individual water facilities. Room temperatures fluctuated between 18 and 20°C. After the beginning of the experiment all the cockerels were fasted for 24 hours to remove previous feed intake, and then about 30 g experimental diet was fed by force feeding to each bird. Endogenous losses were obtained from 15 fasted birds and 40 birds in total were force-fed three feedstuffs. Excreta samples were collected after 48 h, and after being stored in a freezer and were gradually dried at 60°C. The gross energy content of the feedstuff samples and excreta samples was determined by means of a bomb calorimeter.

The gross energy of excrement was corrected to zero nitrogen balance using a factor of 34.4 kJ/g nitrogen (*Hill and Anderson, 1958*). Using data from this study, AME, TME, the nitrogen-corrected apparent metabolisable energy (AMEn) and the nitrogen-corrected true metabolisable energy (TMEn) values of the feedstuffs were determined according to *Sibbald* (*1989*).

For determination of tannin and urease activity of feedstuffs, experiments were carried out by sampling seeds from three different climates in the south-west of the Zagros mountain chain in Kohkiloie Boyerahmad province in Iran. In each of the climates 5-10 samples containing about 1-2 kg of these seeds from different places were collected and dehulled, in the case of the acorns, and then mixed together to make a representative diet for that climate; therefore 3 samples of acorn, 3 samples of Pistacia atlantica (P.at) and 3 samples of Pistacia khinjuk (P.kh) were provided for determination of tannin and urease activity.

The tannin content of the samples was measured according to European Standard No. E2507/1987. In this method the tannin is dissolved from the sample with dimethyl-formamide, and after centrifugation of the sample ammonium-iron(III)-citrate and ammonia solution is added to the supernatant, and the colour obtained is measured by means of a photometer at 525nm.

Urease enzyme activity in the feedstuffs was determined according to Hungarian Standard No. 6830/34-81. The samples were milled as fine as flour and were put into two different phosphate buffer solutions of pH 7.5. The first solution contained urea, while the second solution did not. After 30 minutes at constant 35°C, the pH of the two solutions was measured, and difference in the pH was calculated. Based on the differences in the pH, urease activity was calculated.

The data were analysed by one-way analysis of variance. Significant differences among the treatments were determined by Duncan's new multiple range test (*Duncan, 1955*). Statistical analysis of the experimental results was performed by means of STATGRAPHICS software (Statistical Graphics System) Version 5 and Excel version 5.

RESULTS AND DISCUSSION

The results for gross energy, AME, AMEn, TME and TMEn content of dehulled acorns, Pistacia atlantica and Pistacia khinjuk seeds collected in three different climates in the Zagrossian region are given in *table 1*.

From the results it can be seen that all these new feedstuffs from different climates had individual characteristic apparent and true metabolisable energy values, which are compatible with those of cereal grains in poultry diets. There were no significant differences in AME and TME of dehulled acorns in the different climates. There were significant differences in gross energy at $P<0.01$ level between acorns from the tropical climate and from the cold climate, and at $P<0.05$ level between those from the Mediterranean and from the cold climate, and between those from the tropical and from the Mediterranean climate. AMEn of acorns was affected significantly, with a difference at $P<0.01$ level between the acorns from the tropical and from the cold climates. TMEn of dehulled acorn showed significant differences at $P<0.01$ level between the tropical and the cold climates, and also at $P<0.05$ level between the acorns from the Mediterranean and the cold climates.

These results could be due to the higher crude fat content (8.7%) and also the lower tannin content (4.4%) of the acorns from the cold climate in comparison the lower crude fat content (6.5%) and higher tannin content (4.9%) of those from the tropical climate. These results agree with those who reported that the MEn content of low-tannin sorghum was not different from that of yellow corn. However, the MEn of the high-tannin sorghum proved lower (P<0.05) than that of yellow corn and low-tannin sorghum varieties, and also agree with the findings of *Nelson et al.* (*1975*), *Luis and Nelson* (*1982*) and *Halley et al.* (*1986*), who reported increase in MEn as the tannin content of the sorghum grain decreased. These results are also in agreement with the data of *Butler et al*, (*1984*) who reported that tannin causes binding and precipitation of dietary proteins and digestive enzymes, and may reduce the digestibility of both amino acids (*Armstrong et al., 1974; Nelson et al., 1975*) and energy (*Gous et al., 1982*) of the diet.

Table 1

Gross energy, AME, AMEn, TME, TMEn values of acorns, Pistacia atlantica and Pistacia khinjuk seeds (MJ/kg)

Feedstuffs(1)	Gross Energy(2)	AME	AMEn	TME	TMEn
Acorn-C1(3)	18.27**ae**	13.00	14.58**a**	15.29	12.97**a**
Acorn-C2	18.46**b**	12.86	14.25	15.11	12.47**a**
Acorn-C3	18.63**cf**	13.33	13.43**b**	15.64	14.45b**e**
Mean(4)	18.51	13.06	14.08	15.35	13.30
±SD	0.18	0.24	0.59	0.27	1.03
Pistacia atlantica-C1	25.98	7.68**a**	11.74**a**	13.54	16.22
Pistacia atlantica-C2	26.40	8.76	13.54	14.44	16.49
Pistacia atlantica-C3	26.11	12.50**b**	15.24**b**	17.12	17.75
Mean	26.16	9.65	13.51	15.03	16.82
±SD	0.22	2.52	1.75	1.86	0.81
Pistacia khinjuk-C1	26.21	14.23	17.80	18.87	21.35
Pistacia khinjuk-C2	26.52	10.73	16.89	15.27	20.75
Mean	26.37	12.48	17.33	17.07	21.05
±SD	0.22	2.47	0.67	2.54	0.42

C1: climate 1 or tropical climate (*klíma 1, vagy trópusi klíma*), C2: climate 2 or Mediterranean climate (*klíma 2, vagy mediterrán klíma*), C3: climate 3 or cold climate (*klíma 3, vagy hideg klíma*), SD: standard deviation (*szórás*), Significant differences between the data being in the same column (*Szignifikáns különbségek ugyanabban az oszlopban lévő értékek között*): P<0.05: a-b, c-d, P<0.01: e-f

1. táblázat: A makk, a Pistacia atlantica és a Pistacia khinjuk bruttó energia-, AME, AMEn, TME és TMEn tartalma (kJ/kg)

Takarmány(1), Bruttó energia(2), Makk(3), Átlag(4)

From *table 2* it can be seen that the AMEn of dehulled acorns (14.08±0.59 MJ/kg) is higher than all cereal grain values, but much closer to that of corn (14.02 MJ/kg). The AMEn of Pistacia atlantica (13.51±1.75 MJ/kg) is a little lower than that of corn but higher than that of the others. In the case of Pistacia khinjuk AMEn is 17.33±0.67 MJ/kg. This value is higher than the cereal grains and other feeds shown in *table 2*. These high and individual apparent and true energy values of acorns, Pistacia atlantica and Pistacia khinjuk may be due to individual characteristic values for the nitrogen free extract (NFE), starch and crude fat content of acorns and the high content of crude fat, and also NFE and crude protein, of Pistacia atlantica and Pistacia khinjuk seeds.

Table 2

Comparison of AMEn, TMEn of dehulled acorn, Pistacia atlantica((P.at) and Pistacia khinjuk(P.kh) seeds with cereal grains (NRC 1994, MJ/kg)

Feeds (1)	Acorn (2)	P. at	P. kh	Corn (3)	Sorghum (4)	Wheat (5)	Barley (6)	Triticale (7)	Rye (8)	Oat (9)
AMEn	14.08	13.51	17.33	14.02	13.76	12.59	11.05	13.23	10.99	10.67
TMEn	13.30	16.82	21.05	14.52	14.13	13.25	12.13	13.15	12.26	10.98

2. táblázat: A hántolt makk, a Pistacia atlantica (P.at) és a Pistacia khinjuk (P.kh) AMEn és TMEn tartalmának hasonlítása a gabonafélékhez (NRC 1994, MJ/kg)

Takarmányok(1), Makk(2), Kukorica(3), Cirok(4), Búza(5), Árpa(6), Tritikálé(7), Rizs(8), Zab(9)

The results for tannin content and urease enzyme activity determined in dehulled acorns, Pistacia atlantica and Pistacia khinjuk from different climates in the Zagros area are given in *table 3*.

Table 3

Anti-nutritional factors content of acorn, Pistacia atlantica and Pistacia khinjuk seeds (%)

Antinutri-tional (2)	**Feedstuffs (1)**										
	acorn C. 1	Acorn C. 2	Acorn C. 3	Mean ±SD	P.at C. 1	P.at C. 2	P.at C. 3	Mean ±SD	P.kh C. 1	P.kh C. 2	Mean ±SD
Tannin	4.90	4.80	4.40	4.70 ±0. 26	1.42	1.50	1.37	1.46 ±0.07	1.60	2.26	1.82 ±0.35
Urease activity (3)	0.01	0.03	0.01	0.02 ±0.01	0.01	0.03	0.01	0.02 ±0.01	0.01	0.01	0.01 ±0.002

C1: climate 1 or tropical climate, C2: climate 2 or Mediterranean climate, C3: climate 3 or cold climate (*ld. 1. táblázat*), Mean: average values in a climate (*Különböző éghajlatok átlagai*), SD: standard deviation (*ld. 1. táblázat*)

3. táblázat: A makk, a Pistacia atlantica és a Pistacia khinjuk antinutritív anyagai (%)

Takarmányok(1), antinutritív anyagok(2), Ureáz aktivitás(3)

The results indicate that there are considerable levels of tannin content in dehulled acorn seeds, with a mean value of 4.7%. The tannin content of acorn seeds from different climates were very close to each other. The tannin content of the acorns from the tropical climate was the highest (4.9%) and that of those from the cold climate the lowest (4.4%).

These values could lead to limitations and negative effects in animal nutrition. The tannin content of Pistacia atlantica (1.43%) and Pistacia khinjuk (1.93%) is lower than that of acorns, but may also exert certain anti-nutritional effects.

Urease enzyme activity in dehulled acorns, Pistacia atlantica and Pistacia khinjuk seeds from different climates was almost negligible, between 0 and 0.2. These feedstuffs were raw, but the value of urease enzyme activity was similar to that of soybean after good heat treatment; therefore, with respect to urease enzyme activity these raw feedstuff samples are good and suitable for human and animal consumption.

CONCLUSIONS

According to the results obtained in this study it can be seen that all these new feedstuffs from different climates had individual characteristic apparent and true metabolisable energy values, which are compatible with those of cereal grains in poultry diets. The mean value of AMEn for acorn was 14.08, Pistacia atlantica 13.51 and Pistacia khinjuk 17.33 Mj/kg. The tannin content of acorn was 4.7%, Pistacia atlantica 1.43% and Pistacia khinjuk 1.93%, which are considerable for poultry diets. The rate of urease activity in these seeds was very low.

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REFERENCES

Armstrong, W.D., Rogler, J.C., Featherston, W.R. (1974). In vitro studies of the protein digestibility of sorghum grain. Poult. Sci., 53. 2224.

Baumgras, P. (1944). Experimental feeding of captive fox squirrels. J. Wildl. Mgt., 8. 296.

De Boer, D.E., Bickel, H. (1988). Livestock feed resources and feed evaluation in Europe. Copyright, 1988.

Butler L.G., Riedl, D.J., Lebryk, D.G., Blytt, H.J. (1984). Interaction of proteins with sorghum tannin: mechanism, specificity, and significance. J. Am. Oil Chem. Soc., 61. 916–920.

Duncan, D.B. (1955). Multiple range and multiple F test. Biometrics, 11. 1–42.

Gous, R.M., Kuyper, M.A., Dennison, C. (1982). The relationship between tannic acid content and metabolisable energy concentration of some sorghum cultivates. S. Afr. J. Anim. Sci., 12. 39.

Halley, J.T., Nelson, T.S., Kirby, L.K., York, J.O. (1986). The effect of tannin content of sorghum grain in poultry rations on dry matter digestion and energy utilisation. Arkansas Farm Res. Dept. of Agric. Publ. University of Arkansas, Fayetteville, AR 72701. (March-April) 80.

Hill, F.W., Anderson, D.L. (1958). Comparison of metabolisable energy and productive energy determinations with growing chicks. J. Nutrition, 64. 587-603.

Luis, E.S., Nelson, L.A. (1982). Nutrient composition and feeding value of proso millets, sorghum grains and corn in broiler diets. Poultry Sci., 61. 311-320.

Nelson, T.S., Stephenson, E.L., Burgos, A., Floyd, J., York, J.O. (1975). Effect of tannin content and dry matter digestion on energy utilisation and average amino acid availability of hybrid sorghum grains. Poultry Sci., 54. 1620-1623.
Ofcarcik, R.P., Burns, E.F. (1971). Chemical and physical properties of selected acorns. J. Feed Sci., 36. 576-578.
Sabeti, H. (1994). Forest, Trees, and Shrubs of Iran. 2nd edition. Printed by Iran University of Science and Technology Press, 514-579.
Sibbald, I.R. (1989). Metabolisable energy evaluation of poultry diets, in: Cole, D.J.A., Haresign, W. (1989). (Ed) Recent developments in poultry nutrition 1989. (Tiptree, Essex, Anchor press Ltd). 12-26.
Wanio, W.W., Forbes, E.B. (1941). The chemical composition of forest fruits and nuts from Pennsylvania. J. Agric. Res., 62. 627.

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