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Nutritional Evaluation of Chickpea Wastes for Ruminants Using *In vitro* Gas Production Technique

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Abstract: The present study determines the chemical composition and estimation of nutritive value of 2 types of chickpea wastes including Culled Chickpea (CCP) and Chickpea Dehulling by-Products (CDP) using *in vitro* gas production technique in sheep. The samples were collected from 10 pea packaging and processing factories. The feed samples (200 mg from each) were incubated with rumen liquor taken from three fistulated Ghezel rams at 2, 4, 6, 8, 12, 24, 48, 72 and 96 h. The results showed that Organic Matter (OM), Ether Extract (EE), Non Fibrous Carbohydrates (NFC), starch and Total Phenolic Compounds (TPC) were significantly ($p<0.05$) greater in CCP than that of CDP, but Neutral Detergent Fiber (NDF) were higher in CDP ($p<0.05$). The Crud Protein (CP) and tannins of two feed samples were similar. There were significant differences ($p<0.05$) in Dry Matter Digestibility (DMD), Organic Matter Digestibility (OMD), Short Chain Fatty Acids (SCFA) and Metabolizable Energy (ME) contents ($p<0.01$) of 2 experimental wastes. Gas productions for 24 h were significantly ($p<0.05$) higher in CCP than CDP (75.6 vs. 60.6 mL). The gas production constants values (a, b and c) for CCP were 4.6, 85.3 and 0.05 while for CDP were 4.9, 78.6 and 0.05, respectively. In an overall conclusion it seems that, the nutritive value of CCP was higher than that of CDP.

Key words: Chickpea, gas production, tannin, nutritive value, sheep

INTRODUCTION

Legume grains comprise an important part of the human diet in developing countries in tropical and subtropical areas, where their nutritional contribution is of paramount importance as a large segment of the populations in these areas have limited access to food of animal origin (Bressani, 1975; Ramalho Ribeiro and Portugal Melo, 1990). During the last decades there has been an increase in interest in their role in animal diets (Dixon and Hosking, 1992). Among legume grains, Chickpea is ranking 5th in the total grain legumes production in the world and first in the total grain legumes cultivation area in Iran (Bagheri *et al*., 1997). Although, most chickpeas are produced for human consumption, they provide the livestock industry with an alternative protein and energy feedstuff. The crude protein content of chickpeas ranges from 124-306 g kg^{-1} of dry matter. Chickpea is also a good source of absorbable Ca, P, Mg, Fe and K (Chavan *et al*., 1989; Christodoulou *et al*., 2005).

This legume grain usually used for human nutrition in Iran and many other countries and due to high price, utilization of it in animal nutrition is limited (Maleki Ravasan, 2003). Nutritionally, dry cull peas are excellent source of protein and energy. The value of broken dry peas is greatest when used for animal feed and is very competitive in price as compared to other protein sources. With increased emphasis upon efficiency and cost of production, cull peas could be play a valuable role in reducing feed cost (Hawkins *et al*., 2006). A large amount of chickpea processing by-products and wastes were produced in chickpea processing and packaging units in Iran. The majority of chickpea wastes are culled chickpea (cracked, broken, fine, deformed and impurities) and chickpea processing wastes including chickpea hulls, broken and ground peas and foreign materials (Maleki Ravasan, 2003; Mousavi and Mirza Aghazadeh; 2007; Pourhesabi *et al*., 2007). In spite of using these by-products in some of livestock production farms,

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limited studies were carried on the nutritive value of them (Maleki Ravasan, 2003; Aghdam-Shahriar *et al*., 2004; Hawkins *et al*., 2006; Mousavi and Mirza Aghazadeh, 2007).

Several methods such as *in vivo*, *in situ* and *in vitro* techniques have been used in order to evaluate the nutritive value of feedstuffs. The *in vitro* gas production technique has proved to be a potentially useful technique for feed evaluation (Menke and Steingass, 1988; Getachew *et al*., 2004) as it is capable of measuring rate and extent of nutrient degradation (Cone *et al*., 2002). In addition, *in vitro* gas production technique provide less expensive, easily to determine (Getachew *et al*., 2004) and suitable for use in developing countries (Chumpawadee *et al*., 2005).

The aim of this study was to determine chemical composition and estimation of nutritive value of Culled Chickpea (CCP) and Chickpea Dehulling by-Products (CDP) using *in vitro* gas production technique.

MATERIALS AND METHODS

Animals and feeds: Three fistulated Gezel rams were used for rumen liquor collection in order to application in gas production technique. The experimental samples including Culled Chickpea (CCP) and Chickpea Dehulling by-Products (CDP) were collected from ten chickpea dehulling and packaging units in East Azerbaijan, Iran. The collected samples were mixed and milled through a 1 mm sieve in animal nutrition laboratory of Animal science research institute, Karaj, Iran.

Chemical analysis: Collected samples were milled through a 1 mm sieve for chemical analysis and gas production procedure. Dry Matter (DM) was determined by drying the samples at 105°C overnight and ash by igniting the samples in muffle furnace at 525°C for 8 h. Nitrogen (N) content was measured by the Kjeldahl method. Crude Protein (CP) was calculated as N * 6.25 (AOAC, 1990). Neutral Detergent Fibre (NDF) was determined by procedures outlined by Goering and Van Soest with modifications described by Van Soest *et al*. (1991), sulfite was omitted from NDF analysis.

Starch content was determined by the method of MacRea and Armstrong (1968). Total Phenolic compounds and tannin contents measured through technique out lined by Khazaal *et al*. (1996).

***In vitro* gas production:** Rumen fluid was obtained from three fistulated Gezel rams fed twice daily at the maintenance level with a diet containing alfalfa hay (60%) and concentrate (40%). The samples were incubated in *in vitro* rumen fluid in calibrated glass syringes following the procedures of Menke *et al*. (1979). The 200 mg samples were weighed in triplicate into calibrated glass syringes of 100 mL. The syringes were prewarmed at 39°C before the injection of 30 mL rumen fluid-buffer mixture into each syringe followed by incubation in a water bath at 39°C. Readings of gas production were recorded before incubation (0) and 2, 4, 6, 8, 12, 24, 48, 72 and 96 h after incubation. Total gas values were corrected for blank incubation. Cumulative gas production data were fitted to the model of Orskov and McDonald (1979);

$$Y = a + b\ (1-e^{-ct})$$

Where:

a = The gas production from the immediately soluble fraction (mL).
b = The gas production from the insoluble fraction (mL).
c = The gas production rate constant for the insoluble fraction (b).
a + b = Potential gas production (mL).
t = Incubation time (h).
Y = Gas produced at time t.

The Non Fibrous Carbohydrates (NFC), Short Chain Fatty Acids (SCFA), Digestible Dry Matter (DMD), Digestible Organic Matter (DOM) and Metabilizable Energy (ME) values in experimental by-products were calculated using equations as below:

NFC = 100-(NDF +CP +EE +Ash) (NRC, 2001).
SCFA = 0.0222 Gas – 0.00425 (Makkar, 2005).
DMD = 10.2 (a+b) -1199 (c) + 29 (Khazaal *et al*., 1995).
DOM = 0.9991 Gas + 0.0595 CP + 0.181 CA + 9 (Menke and Steingass, 1988).
ME = 0.157 Gas + 0.0084 CP + 0.022 EE – 0.0081 CA + 1.06 (Menke and Steingass, 1988).

Where, Gas is gas production at 24 h incubation (mL 200 mg^{-1} DM) a, b and c are gas production parameters described by Orskov and McDonald (1979) and NDF, CP, EE, CA are neutral detergent fiber, crude protein, ether extract, crude ash (% DM), respectively.

Statistical analysis: All of the data were analyzed by using software of SPSS (2002) and means of two sample groups were separated by independent-samples t-test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Chemical composition of the two chickpea wastes are presented in Table 1. The organic matter, ether extract, cell wall, non fibrous carbohydrate, total phenolic compounds, starch and soluble sugar contents of Culled Chickpea (CCP) and chickpea processing wastes (CDP)

Table 1: Chemical composition of experimental chickpea wastes as to dry matter basis (%)

Constituents	Culled Chickpea (CCP)	Chickpea Dehulling by-Products (CDP)	Significance
Dry matter	89.78	90.17	NS
Organic matter	96.90	92.20	*
Crude protein	19.70	21.80	NS
Neutral Detergent Fiber (NDF)	21.70	26.30	*
Ether Extract (EE)	7.80	3.10	*
Total tannin	0.06	0.01	NS
Total Phenolic compounds	0.27	0.14	*
Non Fibrous Carbohydrate (NFC)	51.30	39.90	*
Starch	27.30	5.10	*
Soluble sugars	7.50	4.10	*

NS: Non Significant, *: $p<0.05$

were significantly different ($p<0.05$), although the crude protein and total tannin contents between experimental groups were not significantly different. The DM, CP and EE content of CDP were in agreement with those of reported by Maleki Ravasan (2003), Aghdam-Shahriar *et al.* (2004) and Mousavi and Mirza Aghazadeh (2007). The values for DM, CP and EE in their researches were (91.5, 20 and 3%), (91.2, 20.3 and 3.25%) and (91.5, 20 and 2%), respectively, but OM contents were higher than those reported by same authors. The difference may be due to the different ratio of hulls in the wastes obtained by different sampling methods in different years and the precision of handling methods in the processing units.

The CP, EE, starch and soluble sugars content of CCP were lower than that reported by Cone *et al.* (2002) and Wang and Daun (2004). The EE, NDF and tannin contents were higher than those reported by Cordesse (1990) and Masoero *et al.* (2005). The wide variations on the chemical composition of various chickpea were probably due to different climatic condition, geographical distribution and chickpea varieties (Ramalho Ribeiro and Portugal Melo, 1990; Wang and Daun, 2004). It seems that impurities in CCP used in current experiment partially may be responsible for the difference shown with that reported by those reports. The differences in chemical composition of CCP and CDP (Table 1) could be due to different ratio of hulls, the extent of foreign materials and different varieties of culled chickpeas (*kabuli*) and Chickpea Dehulling by-Products (*desi*) (Wang and Daun, 2004).

Gas production parameters (a, b, c) and gas production volume (mL 200 mg^{-1} DM) in different incubation times and calculated amounts of SCFA, DMD, OMD and ME of CCP and CDP are presented in Table 2 and 3.

The gas volume for CCP and CDP in different incubation times (exception 2 h) were significantly different ($p<0.05$). The gas volume at 24 h incubation (for 200 mg dry samples), soluble fraction, insoluble but fermentable fraction for CCP were 75.61, 4.64 and 85.32 and for CDP were 60.6, 4.93 and 78.61 mL, respectively (Table 2). Rate of gas production expressed in mL h^{-1} was found 0.05 for both feedstuffs. The ME, SCFA and DMD and OMD of CCP was significantly higher than that of CDP ($p<0.05$). The ME content of CCP and CDP in this experiment were 13.26 and 10.76 MJ kg^{-1} DM (Table 3), respectively that were almost in agreement with Hawthorne (2006) for Australian varieties (12.1 MJ kg^{-1} DM) and also for Mediterranean chickpeas (11.8-13.2) reported by Ramalho Ribeiro and Portugal Melo (1990).

Table 2: Comulative gas production volume (mL per 200 mg) at different incubation times for experimental chickpea wastes

Incubation times	Culled Chickpea (CCP)	Chickpea Dehulling by-Products (CDP)	Significance
2	4.60	4.90	NS
4	9.30	9.80	*
6	16.60	16.20	*
8	22.90	24.70	*
12	50.70	38.50	*
24	75.60	60.60	*
48	81.90	73.60	*
72	83.90	76.40	*
96	85.30	78.60	*

NS: Non Significant, *: $p<0.05$

Table 3: The gas production parameters, Dry Matter Digestibility (DMD), Organic Matter Digestibility (OMD), Short Chain Fatty Acids (SCFA) and Metabolizable Energy (ME) contents of experimental chickpea wastes

Items	Culled Chickpea (CCP)	Chickpea Dehulling by-Products (CDP)	Significance
a (mL)	4.60	4.90	NS
b (mL)	85.30	78.60	*
c (mL h^{-1})	0.05	0.05	NS
DMD (%)	88.70	82.10	*
OMD (%)	85.76	70.98	*
SCFA (mmol)	1.70	1.30	*
ME (MJ kg^{-1} DM)	13.26	10.76	**

a: The gas production from the immediately soluble fraction (mL), b: The gas production from the insoluble fraction (mL), c: The gas production rate constant for the insoluble fraction (b), NS: Non Significant *: $p<0.05$ **: $p<0.01$

CONCLUSION

In an overall conclusion the nutritive value (chemical composition, gas production characteristics, dry matter digestibility, organic matter digestibility and metabolizable energy) of culled chickpeas were better than that of chickpea processing wastes. However, both by-products could be used as potential energy and protein sources in ruminant nutrition.

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REFERENCES

Aghdam-Shahriar, H., A.R. Ahmadzadeh, N. Maheri and R. Aliverdi Nasab, 2004. The survey application different levels of dehull pea waste in Japanes quail diets. Proc. 12th World Poultry Congress. Istanbul Turkey, pp: 984 (Abst).

AOAC, 1990. Official Method of Analysis. 15th Edn. Washington DC. USA: Association of Official Analytical Chemists, pp: 66-88.

Bagheri, A., A. Nezami, A. Ganjali and M. Parsa, 1997. The chickpea. Jihad Daneshi Mashhad Press, pp: 444.

Bressani, R., 1975. Legumes in Human Diets and How They Might Be improved. In: Nutritional Improvement of Food Legumes by Breeding Milner, M. (Ed.). Wiley, New York, pp: 15-42.

Chavan, J.K., S.S. Kadam and D.K. Salunke, 1986. Biochemistry and technology of chickpea (*C. arietinum*) seeds. CRC Crit. Rev. Food Sci. Nutr., 25: 107-132.

Christodoulou, V., V.A. Bampidis, B. Hucko, K. Ploumi, C. Iliadis, P.H. Robinson and Z. Mudrik, 2005. Nutritional value of chickpeas in rations of lactating ewes and growing lambs. Anim Feed Sci. Technol., 118: 229-241.

Chumpawadee, S., K. Sommart, T. Vongpralub and V. Pattarajinda, 2005. Nutritional evaluation of non forage high fibrous tropical feeds for ruminant using *in vitro* gas production technique. Pak. J. Nutr., 4: 298-303.

Cone, J.W., A.H. Van Gelder, H. Bachman and V.A. Hindle, 2002. Comparison of organic matter degradation in several feedstuffs in the rumen as determined with the nylon bag and gas production technique. Anim. Feed. Sci. Technol., 96: 56-67.

Cordesse, R., 1990. Value of chickpea as animal feed. Options Mediterranean's-Serie Seminaires, 9: 127-131.

Dixon, R.M. and B.J.Hosking, 1992. Nutritional value of grain legumes for ruminants. Nutr. Res. Rev., 5: 19-43.

Getachew, G., P.H. Robinson, E.J. DePeters and S.J. Taylor, 2004. Relationships between chemical compositions, dry matter degradation and *in vitro* gas production of several ruminant feeds. Anim. Feed Sci. Technol., 111: 57-71.

Hawkins, E.W., D.K. Lunt, L.E. Orme and N.P. Johnston, 2006. Utilisation of cull peas, dry beans and bakery wastes for feeding swine. J. Anim. Vet. Adv., 5: 1014-1021.

Hawthorne, W., 2006. Pulses nutritional value and their role in the feed industry. Pulse Australia (GRDC), pp: 6-14.

Khazaal, K., M.T. Dentinho, J.M. Ribeiro and E.R. Ørskov, 1995. Prediction of apparent digestibility and voluntary feed intake of hays fed to sheep: Comparison between using fibre component, *in vitro* digestibility or characteristics of gas production or nylon bag degradation. Anim. Sci., 61: 527-538.

Khazaal, K., Z. Parissi, C. Tsiouvaras, A. Nastis and E.R. Orskov, 1996. Assessment of phenolics-related antinutritive levels using the *in vitro* gas production technique: A comparison between different molecular weight of Polyvinylpolypyrrolidone or Polyethylene glycol. J. Sci. Food. Agric., 71: 405-414.

MacRae, J.C. and D.G. Armstrong, 1968. Enzyme method for determination of á-linked glucose polymers in biological materials. J. Sci. Food. Agric., 19: 578-581.

Makkar, H.P.S., 2005. *In vitro* gas methods for evaluation of feeds containing phytochemicals. Anim. Feed Sci. Technol., 123-124: 291-302.

Masoero, F., A.M. Pulimeno and F. Rossi, 2005. Effect of extrusion, expansion and toasting on the nutritional value of peas, faba beans and lupines. Ital. J. Anim. Sci., 4: 177-189.

Menke, K.H., L. Raab, A. Salewski, H. Steingass, D. Fritz and W. Schneider, 1979. The estimation of digestibility and metabolizable energy content of ruminant feeding stuffs from the gas production when they are incubated with rumen liquor *in vitro*. J. Agric. Sci. Camb., 93: 217-222.

Menke, K.H. and H. Steingass, 1988. Estimation of energetic feed value obtained from chemical analysis and *in vitro* gas production using rumen fluid. Anim. Res. Dev., 28: 7-55.

Mousavi, S.H. and A. Mirza Aghazadeh, 2007. Study on replacing cotton seed meal and barely by chickpea processed by-product on performance and carcass characteristics of Iranian Kizil and Makui male lambs. Proceeding of the second Congress on Animal and Aquatic Sciences, Karaj, Iran, pp: 921-924.

NRC, 2001. Nutrient Requirements of Dairy Cattle. 7th Rev. Edn. National Academy of Science. National Research Council, Washington, DC.

Orskov, E.R. and P. McDonald, 1979. The estimation of protein degradability in the rumen from incubation measurements weighed according to rate of passage. J. Agric. Sci., 92: 499-503.

Pourhesabi, G.H., H. Khamisabadi, H. Yaghobfar and A. Parvaneh, 2007. Effects of different levels of the chickpea seeds waste on the performance of broilers. Proceeding of the second Congress on Animal and Aquatic Sciences, Karaj, Iran, pp: 270-273.

Ravasan, M.Y., 2003. Study of growth potential of Holstein male calves fed with rations of different levels of pea's by-product. M.Sc.Thesis in animal sciences. Islamic Azad University, Shabestar Branch, pp: 55.

Ribeiro, R.J.M.C. and I.M. Portugal Melo, 1990. Composition and nutritive value of chickpea. Options Mediterranean's-Serie Seminaires, 9: 107-111.

SPSS User Guide, 2002. SPSS 11.0. Information Technology Services Centre. Lingnan University. Hong Kong.

Steel, R.G. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edn. McDonald Book Co., Inc., New York.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for Dietary Neutral Detergent Fiber and Non Starch Polysaccharides in relation to animal Nutrition. J. Dairy Sci., 74: 3583-3597.

Wang, N. and J.K. Daun, 2004. The Chemical composition and nutritive value of Canadian pulses. Can. Grain Comm. (CGC), pp: 19-29.