Apparent metabolisable energy content of fenugreek (Trigonella foenum-graecum L.) seed and Galactomannan depleted fenugreek residue in roosters

Yasothai R

DOI: https://doi.org/10.22271/tpi.2021.v10.i9p.7772

Abstract
A study was carried out to estimate the apparent metabolisable energy contents of fenugreek seed and galactomannan depleted fenugreek residue (GDFR) using roosters. The apparent metabolisable energy content in the fenugreek seed and galactomannan depleted fenugreek residue was 3125 and 3315 kcal/kg. Based on the present results, it is concluded that fenugreek seed and GDFR is a potential energy supplement for poultry.

Keywords: Fenugreek seed, GDFR, apparent metabolisable energy, roosters

Introduction
India, the spice bowl of the world with more than 50 varieties of spices being produced. The total production of spices in India is estimated at 5.8 million tonnes and it accounts for over 45 percent of the world spice trade by volume and value. Fenugreek, an important spice was produced to the tune of 1.279 lakh tones in the year 2010-11. Rajasthan accounts for 74% of the fenugreek seed produced in India [1]. Fenugreek (Trigonella foenum-graecum L.) is known as methi in Hindi and vendayam in Tamil. The largest producer of fenugreek in the world is India. In India, the seeds are used in curries (preparation of pickles, vegetable dishes, dhals and spice mixes such as Panch Phoron and sambar powder) and for its medicinal properties viz., anti-diabetic and cholesterol lowering properties [2-5], anti-hyperthyroid effects [6], against thyroxine-induced hyperglycemia [7], anti-cancer effects [8], gastro-protective effects [9], antioxidant property [10], antinociceptive property [11], antimicrobial property [12], anthelmintic property [13], anti-sterility and anti-androgenic effects [14], wound healing property [15] and also anti-inflammatory and antipyretic actions [16].

Galactomannan in fenugreek, due to its viscous property, is effective in inhibiting the intestinal glucose uptake and lower blood glucose [17], hence separation of galactomannan are undertaken at industrial levels (eg. M/s. E.I.D. Parry (India) Limited, Bio Products Division, Cuddalore, Tamil Nadu, India) to produce anti-diabetic nutraceutical. The residue is designated as Galactomannan Depleted Fenugreek Residue (GDFR) and marketed as Fenumax®. With the increased incidence of diabetes in India and the clamour for using natural drugs for diabetes, the growth of galactomannan separation from fenugreek is likely to increase resulting in more quantity of the GDFR available.

Galactomannan are the major polysaccharide found in fenugreek seed and represent approximately 50% of the seed weight [18]. The remaining 50% of the material from fenugreek galactomannan extraction industry is available as galactomannan depleted fenugreek residue (GDFR). Extractable oil from fenugreek represents about 6 - 8% of the seed weight and contains ω-3(n-3), ω-6(n-6), and ω-9 (n-9) fatty acids along with many saponins, alkaloids, and sterols [19-20]. Shahat [21] studied Egyptian fenugreek oil and reported that it consists of 33.7% linoleic, 35.1% oleic and 13.8% linolenic acids. Baccou et al [22] studied the fatty acid composition of fenugreek oil from different countries and found that the percentage of linoleic and linolenic acids differ according to place and conditions of cultivation of plant, and the oils had marked drying properties.

Dietary fatty acids modify the plasma lipoprotein profile and reduce the risk of cardiovascular disease, which has been shown in intervention studies [13-25] in particular for polyunsaturated
and monounsaturated fatty acids. The active therapeutic constituents of fenugreek seeds are 4-hydroxy isoleucine [26], lysine and L-tryptophan rich proteins, mucilaginous fibre (galactomannan) and other rare chemical constituents such as saponins, coumarin, fenugreekine, nicotinic acid, sapogenins, phytic acid, scopoletin and trigonelline, which are thought to account for many of its presumed therapeutic effects like, inhibition of cholesterol absorption and lowering blood sugar level [27].

Fenugreek seed and GDFR contain 24 - 26% and 26 - 32% protein, respectively. Since both the products have high carbohydrate content, the expected energy value is presumed to be equivalent to cereals. In addition, these products possess nutraceutical value.

The gross, apparent and true metabolizable energy content of fenugreek seed were 3994, 2368 and 3877 kcal/kg as per the report of Kochhar et al. [28], Elmman et al. [29] and Mahmoud et al. [30] respectively. The metabolizable energy content of maize was 3309 kcal/kg [31].

In view of the above, the present work was undertaken to estimate the apparent metabolisable energy (AME) content of fenugreek seed and galactomannan depleted fenugreek residue (GDFR) in roosters.

Methodology
The fenugreek seed sample used for conducting biological trial was procured locally. The samples were ground and used for analyses.

The samples of GDFR (Parry Fenumax®) test sample used in the biological trial was received from E.I.D. Parry (India) Limited, Parry Nutraceuticals Division, Chennai, Tamil Nadu. The biological experiment in roosters were carried out in the Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, following the standard procedures to assess the nutritive value of fenugreek seed and galactomannan depleted fenugreek residue.

Apparent metabolisable energy
The apparent metabolizable energy content of fenugreek seed and galactomannan depleted fenugreek residue test sample was estimated in roosters (21 week-old) as per the method of Sibbald [32]. A total of sixteen roosters were randomly divided into two groups of eight birds each and housed in an individual metabolic cages. One group was fed with fenugreek seed test material and another group was fed with galactomannan depleted fenugreek residue test material ad libitum for three days for adaptation. Then the birds were starved for 24 h.

Each bird in the first and second group was fed with 50 g of fenugreek seed and galactomannan depleted fenugreek residue test material respectively. The excreta for 24 h period in both the groups were collected, thoroughly homogenized, weighed and dried in a hot air oven at 80°C for 24 h and the dry matter was estimated. The calorific values of fenugreek seed and galactomannan depleted fenugreek residue as well as the excreta were assayed in an adiabatic bomb calorimeter adopting the standard procedure. The analyzed values were used to arrive at the apparent metabolisable energy content of the fenugreek seed sample and galactomannan depleted fenugreek residue sample using the following formula:

\[ \text{AME (kcal/g air dry) = ((Gef \times X) – Yef) / X} \]

Where, Gef is the gross energy of the feeding stuff (kcal/g); Yef is the total gross energy voided in the excreta by the fed bird (kcal); X is the weight of the feed (g).

Statistical analysis
Data collected during the investigation were subjected to statistical analysis as per Snedecor and Cochran [33].

Results and Discussion
The apparent metabolisable energy of fenugreek seed and GDFR are presented in Table 1. The gross energy content of fenugreek seed and GDFR were 4265 ± 14 kcal/kg and 4537 ± 37 kcal/kg respectively. The apparent metabolisable energy of fenugreek seed and GDFR were 3125 ± 0.02 kcal/kg and 3315 ± 0.03 kcal/kg respectively.

Table 1: Metabolisable energy (kcal/kg) content of fenugreek seed and GDFR (on DM)

| Energy content       | Fenugreek Seed | GDFR          |
|----------------------|----------------|---------------|
| Gross energy (kcal/kg)| 4265 ± 14      | 4537 ± 37     |
| Metabolisable energy (kcal/kg)| 3125 ± 0.02 | 3315 ± 0.03   |

Each value is a mean of eight observations.

The apparent metabolisable energy of fenugreek seed observed in this study was higher than the value reported by Elmman et al. [29]. The variation might be due to high nitrogen free extract and low crude fibre content in fenugreek seed samples used in this study. The apparent metabolisable energy of GDFR was higher than fenugreek seed. Galactomannan is present in fenugreek seed up to 50 per cent. Galactomannan was known to increase intestinal viscosity in poultry [34] and reduced glucose absorption [35], hence the metabolisable energy (ME) value of fenugreek seed might have been lower than GDFR. The ME value of GDFR and maize was comparable.

Conclusions
This study revealed that the gross energy content of fenugreek seed and GDFR were 4265 ± 14 kcal/kg and 4537 ± 37 kcal/kg respectively. The apparent metabolisable energy of fenugreek seed and GDFR were 3125 ± 0.02 kcal/kg and 3315 ± 0.03 kcal/kg respectively.

Acknowledgements
The authors are thankful to the Dean, Veterinary College and Research Institute, Namakkal, Tamilnadu Veterinary and Animal Sciences University (TANUVAS), for providing the necessary facilities to carry out this work as part of the Ph.D. programme.

References
1. Anonymous. Spice Board India, Ministry of Commerce and Industry, Government of India, DASD, Calicut 2010.
2. Hannan JMA, Rokeya B, Faruque O, Nahar N, Moshiuzzaman M et al., Effect of soluble dietary fibre fraction of Trigonella foenum-graecum on glycemic, insulinemic, lipidemic and platelet aggregation status of Type 2 diabetic model rats, J Ethnopharmacol 2003;88:73-77.
3. Vats V, Yadav SP, Grover JK, Effect of Trigonella foenum-graecum on glycogen content of tissues and the key enzymes of carbohydrate metabolism, J Ethnopharmacol 2003;28:1-6.
4. Venkatesan N, Devaraj SN, Devraj H. Increased binding of LDL and VLDL to apo B, E receptors of hepatic plasma membrane of rats treated with Fibranat, Eur J Nutr 2003;42:262-271.

5. Suboh SM, Bilto YY, Aburjai TA. Protective effects of selected medicinal plants against protein degradation, lipid peroxidation and deformability loss of oxidatively stressed human erythrocytes, Phyther Res 2004;18:280-284.

6. Tahiliani P, Kar A. The combined effects of Trigona and Allium extracts in the regulation of hyperthyroidism in rats, Phyto medicine 2003:10:665-668.

7. Tahiliani P, Kar A. Mitigation of thyroxine-induced hyperglycaemia by two plant extracts, Phyther Res 2003;17:294-296.

8. Devasena T, Menon VP. Fenugreek affects the activity of beta-glucuronidase and mucinase in the colon, Phyther Res 2003;17:1088-1091.

9. Pandian RS, Anuradha CV, Viswanathan P. Gastroprotective effect of fenugreek seeds (Trigonella foenum-graecum) on experimental gastric ulcers in rats, J Ethnopharmacol 2002;81:393-397.

10. Raskin I, Ribnicky DM, Komarnytsky S, Llic N, Poulev A et al. Plants and human health in twenty-first century, Trends Biotechnol 2002;20:522-531.

11. Javan M, Ahmadiani A, Semnanian S, Kamalinejad M. Antinociceptive effects of Trigonella foenum-graecum leaves extract, J Ethnopharmacol 1997;58:125-129.

12. Bhatti M, Khan AMTJ, Ahmed M, Jamshaid W, Ahmad W. Antibacterial activity of Trigonella foenum-graecum seeds, Phytother Res 1996;67:372-374.

13. Ghafgaz M, Bilto Y, Pourafkari A. In vitro study of the action of Trigonella foenum-graecum grown in Iran, Iranian J Pub Health 1980;9:21-26.

14. Kamal R, Yadav R, Sharma JD. Efficacy of steroidal fraction of the fenugreek seed extract on the fertility of male albino rats, Phyther Res 1993;7:134-138.

15. Taranalli AD, Kuppast JJ. Study of wound healing activity of seeds of Trigonella foenum-graecum in rats, Indian J Pharm Sci 1996;58:117-119.

16. Ahmadiani A, Javan M, Semnanian S, Barat E, Kamalinejad M. Anti-inflammatory and antipyretic effects of Trigonella foenum-graecum leave extracts in the rat, J Ethnopharmacol 2001;75:283-286.

17. Srichamroen A, Thomson ABR, Field CJ, Basu TK. In vitro intestinal glucose uptake is inhibited by galactomannan from Canadian fenugreek seed (Trigonella foenum-graecum L.) in genetically lean and obese rats, Nutr Res 2009;29:49-54.

18. Raghuram TC, Sharma RD, Sivakumar B, Sahay BK. Effect of fenugreek seeds on intravenous glucose disposition in non-insulin dependent diabetic patients, Phyther Res 1994;8:83-86.

19. Heller L. Fenugreek. A noteworthy hypoglycemic, Pacific College of Oriental Medicine 2001. From www.ormed.edu/newsletters/fenugreek.html.

20. El-Sebaiy A, El-Mahdy AR. Lipid changes during germination of fenugreek seeds (Trigonella foenugraecum), Food Chem 1983;10:309-319.

21. Shahat M. The analytical constants and composition of fatty acids of Egyptian fenugreek oil, Proceedings of the 11th Congress in Pure and Applied Chemistry, London 1947,569–575p.

22. Baccou JC, Sauvare Y, Olle M, Petit J. L’huile de Fenugreek. Composition, properties, possibilities d’utilisation dans l’industrie des peintures et vernis, Revue Francaise des Corps Gars 1978;25:353-359.

23. Wolfram G. -3 and -6 Fettauransen: Biochimische Besonderheiten und Biologische Wirkungen, Fat Science Technology 1989;12:459-468.

24. Kinsella JE, Lokes B, Stone RA. Dietary n-3 poly unsaturated fatty acids and amelioration of cardiovascular disease: possible mechanisms, American J of Clinical Nutrition 1990;52:1-28.

25. Harris WS. n-3 fatty acids and serum lipoproteins, human studies, American J of Clinical Nutrition 1997;65(Suppl. 5):S1645-S1654.

26. Hajimehdipoor H, Sadat-Ebrahim SE, Izaddoost M, Amin GR, Givi E. Identification and quantitative determination of blood lowering sugar amino acid in fenugreek, Planta Medica 2008;74:1175-1185.

27. Bakhari SB, Bhanger MI, Memon S. Antioxidant activity of extracts from fenugreek seeds (Trigonella foenum-graecum), Pak. J Anal. Environ. Chem 2008;9:78-83.

28. Kochhar A, Nabi M, Sachdeva R. Proximate composition, available carbohydrates, dietary fibre and antinutritional factors of selected traditional medicinal plants, J Hum Ecol 2006;19:195-199.

29. Elmnan AA, Balgees A, Mangara J. Effect of fenugreek (Trigonella foenum-graecum) seed dietary levels on lipid profile and body weight gain of rats, Pak J Nutr 2012;11:1004-1008.

30. Mahmoud NY, Salem RH, Mater AA. Nutritional and biological assessment of wheat biscuits supplemented by fenugreek plant to improve diet of anemic rats, Acad J Nutr 2012;1:1-9.

31. NRC. Nutrient Requirements of Poultry (9th revised ed.), National Academy Press, Washington, DC 1994.

32. Sibbald IR. A bioassay for true metabolizable energy in feeding stuffs, Poultry Science 1976;55:303-308.

33. Snedecor GW, Cochran WG. Statistical Methods (8th edn), Iowa State University Press, Ames, Iowa, U.S.A 1989.

34. Edith AC, Cartwright L, Sij J. Guar meal could be used as chicken feed, Agnews news and public affairs Texas A&M University system agriculture program 2002.

35. Rainbird AL, Low AG, Zebrowska T. Effect of guar gum on glucose and water absorption from isolated loops of jejunum in conscious growing pigs, Br J Nutrition 1984;52:489-498.