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Green Pea Pod Residue-As an Alternative Feeds for Dairy Animals: A Review

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ABSTRACT

Livestock gives a substantial contribution in sustaining rural economy and livelihood and up liftment of socio-economic status of rural people. The contribution is nearly 4.11 per cent to total GDP and 25.6% of total Agriculture GDP. Present livestock population of 535.78 million registered an increase of 4.6% over Livestock Census 2012. In India availability of feed stuffs both in quantitative and qualitative forms has been the major constraint for sustaining positive growth in Indian livestock sector. Latest estimate on demand-supply gap in fodder availability shows a net deficit of 30.65% green fodder and 11.85% dry crop residues in year 2020. Pea seeds are regarded as a highly valuable protein source for nutrition due to their high protein content (about 22-24%) which is intermediate between cereals and oil meals. Empty pea pods have been reported to contain 19.8% crude protein and 1.0% ether extract, rich in total soluble sugars (35.8%), total phenolics (9.4%) and macro and micro minerals. The digestion kinetic parameters for dry matter revealed that pea pods had 82.3 per cent degradable fractions and 68-69 per cent effective and true degradability. In India, total quantity of green pea pods available on annual basis accounts to 68.5×10^3 tones. Pea pods are relished by ruminants and are highly palatable with high nutritive value and an effective method of utilization of pea waste after removal of pea grains from pea pods as complete feed in ruminant animals.

Key words: Alternate feeds, Body condition score, Milk production, Nutrients intake, Pea pods residue, Total phenolics.

India is an agrarian country where a large population is practising farming as their prime occupation. Livestock give a substantial contribution in sustaining rural economy and livelihood and upliftment of socio-economic status of rural people. It contributes, nearly 4.11 per cent to total GDP and 25.6% of total agriculture GDP. Present livestock population of 535.78 million registered an increase of 4.6% over Livestock Census 2012. India has a population of over 300 million bovines as per the 2019 livestock census, including 192.49 million cattle and 109.85 million buffaloes. In 2019, the Indian dairy sector was reported to be growing at 4.9% yearly. In 2018-19, the Government of India reported that 187.7 million tonnes of milk had been produced and that the per capita availability of milk in India was 394 grams per day (DAHD, 2017-18).

By 2050 the world will need to feed an additional 2 billion people and require 70 per cent more meat and milk. In India availability of feed stuffs both in quantitative and qualitative forms has been the major constraint for sustaining positive growth in Indian livestock sector. Latest estimate on demand-supply gap in fodder availability shows a net deficit of 30.65% green fodder and 11.85% dry crop residues in year 2020 (IGFRI Vision, 2050). Using agricultural waste such as green pea pods residue in animal feeding is an interesting way to reduce feed cost and environmental pollution. In order to bridge the estimated gap between availability and requirements of feed, new avenues are to be continuously explored and one such emerging category of by-products is green pea pods residue.

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Pea pods

The pea classified into Kingdom: Plantae, Order: Fabales, Family: Fabaceae/Leguminaceae, Genus: Pisum, Species: *Pisum sativum* L. Field pea (*Pisum sativum)* is a cool-season legume crop that is palatable and nutritious as seed and forage. The seed is an excellent source of protein (24.3%) (Lardy and Anderson, 2009) and energy (0.70 Mcal NEg per pound) (NRC, 2001) and other nutrients. The pea is the small spherical seeds of the pod fruit *Pisum sativum.* Each pod contains several pea seeds. Peas are starchy, but high in fiber, protein, vitamin A, vitamin B_6, vitamin C, vitamin K, phosphorus, magnesium, copper, iron, zinc and lutein. Pea seeds are regarded as a highly valuable protein source for nutrition due to their high protein content (about 22-24%) which is intermediate between cereals and oil meals (Castell *et al.,* 1996). Pea peels have good nutritional value and

hence value added feeds can be prepared by using pea peels. Pods are dehiscent and contain several seeds that may be globular or angled, smooth or wrinkled (FAO, 2011; Muehlbauer and Tullu, 1997).

Pea pods residue in animal nutrition

Empty pea pods have been reported to contain 19.8% crude protein and 1.0% ether extract, rich in total soluble sugars (35.8%), total phenolics (9.4%) and macro and micro minerals. The empty pea pods are rich in crude protein (19.8%), soluble sugars, phenolics and macro- and micro-elements. The digestion kinetic parameters for dry matter revealed that pea pods had 82.3 per cent degradable fractions and 68-69 per cent effective and true degradability. In India, total quantity of green pea pods available on annual basis accounts to 68.5×10^3 tones. Pea pods are relished by ruminants and are highly palatable with high nutritive value and an effective method of utilization of pea waste after removal of pea grains from pea pods as complete feed in ruminant animals (Wadhwa *et al.,* 2006).

Effect of pea pods residue feeding on nutrients intake and digestibility

Wenk and Zurcher (1990) found that soybean hulls and barley hulls proved to be very well suited for growing pigs (11.4 MJ DE/ kg DM and 10.0 MJ DE/ kg DM, respectively) However pea hulls showed a mean content of digestible energy (5.6 MJ DE/ kg DM), whereas the millet hulls (1.1 MJ DE/ kg DM) did not contribute significantly to the energy supply of the pigs. Gdala *et al*. (1992) analyzed for content of nutrients and some anti-nutritional factors in six varieties of white flowered and three varieties of coloured flowered peas and observed that colour flowered varieties of pea has significantly more NDF ($P<0.05$), lignin and tannins ($P<0.01$) than the white flowered peas whereas trypsin inhibitor activity ranged widely in both white and coloured flowered peas and methionine, cystine and threonine were negatively correlated with the protein content of the tested seeds and the true ileal and faecal digestibilities of pea protein ranged from 66 to 83% and from 74 to 88%, respectively in cannulated pigs. Corbett *et al*. (1995) concluded that peas can be substituted for soybean meal and canola meal as a protein source for high-producing dairy cows. Cows fed extruded peas had higher dry matter intake than those fed with soybean meal and no differences were observed between cows fed extruded and raw peas (Petit *et al*. 1997). Birkelo *et al*. (2000) reported that there were no differences between whole and rolled pea treatments for finishing diets in cattle and also dry matter intake did not differ between control and pea treatments from day 1 to 56, day 57 to 105 or overall. Khorasani *et al.* (2001) observed that substitution of peas for soybean meal (SBM) and barley at levels of 0%, 33%, 67% and 100% of the concentrate did not influence dry matter and crude protein intakes and also observed that substitution of SBM and barley grain with peas may alter the site and end-products of digestion. Ipharraguerre and Clark (2003) found that legume hulls can replace cereal grain to supply 30% of the dry matter in high-grain diets without negatively affecting the fermentation or digestion of nutrients in the gastrointestinal tract or the performance of dairy cows. The field peas can be used as an ingredient in creep feed to increase calf weight gain without negatively affecting ruminal fermentation and digestion (Gelvin *et al*. 2004). Moreover in beef steers treatments were field pea replacing corn at 0%, 33%, 67%, or 100% found that field pea is a highly digestible legume grain that ferments rapidly because of their relatively high level of protein, it will decrease the need for protein supplementation (Reed *et al.* 2004). Although in growing pigs fed South Dakota-grown field peas (*Pisum sativum* L.) observed that the nutrients in field peas were highly digestible and in diets for nursery pigs and growing- finishing pigs in amounts of at least 18 and 36%, respectively, without negatively affecting pigs performance (Stein *et al*. 2004). Collins *et al*. (2006) found that the *ileal* dry matter digestibility was significantly reduced in the transgenic peas compared with the non-transgenic peas *i.e*. 12.7% and 69.9%, respectively, which was largely due to reduced starch digestibility and apparent crude protein (CP) digestibility of the transgenic peas were found similar to the non-transgenic being 79.7% and 78.5%, respectively however amino acid digestibility of the transgenic and non-transgenic peas were also similar. Masoero *et al*. (2006) reported that when the pea (2.5 kg/cow/day) partially replaced the soybean meal and totally replaced the barley meal of the base diet, the unprocessed or differently processed pea did not affect the dry matter intake of dairy cows. The replacement of grass, silage with pea- barley silage had no effect on, apparent digestibility of diet organic matter and crude protein, however, digestibility of diet neutral detergent fibre decreased linearly ($P<0.01$) as the proportion of pea barley silage in the feeding increased (Pursiainen and Tuori 2006). There were no differences among treatments for dry matter intake or organic matter intake in pulse grains in receiving diets for cattle and no treatment effects for apparent ruminal and total tract OM digestibilities were found when pulse grains replaced corn and canola meal and also crude protein intake, microbial crude protein flow, total tract crude protein digestibility and microbial efficiency were also not influenced by treatment however, total-tract ADF and NDF digestibilities were greater with field pea as compared to control but total VFA concentrations were lower for field pea and lentil compared with control and also chickpea, field pea and lentil had lower acetate molar proportion than control observed by Gilbery *et al*. (2007). Soto Navarro *et al*. (2012) observed that the supplementation of field pea to gestating cows consuming medium-quality grass hay increased total dry matter intake. Although, the highest cow-calf net return was from the starch base with soyabean meal, fibre base with 20% pea and fibre base with 30% pea weaning transition diet treatments ($P<0.001$) as reported by Senturklu and Landblom (2015). Tusnio *et al*. (2017) observed that the animals fed the

extruded pea diet had a significantly better apparent protein digestibility than those fed with raw pea seeds.

Effect of pea pods residue feeding on growth performance

Birkelo *et al*. (2000) found that steers consuming the pea diets grew faster than control group in a 56 days feeding trial but slower from 57 to 105 days. As a result, overall daily gain did not differ among treatments. However, the replacement of soybean meal with peas did not significantly affect growth performance observed by Lanza *et al*. (2003). The field peas can be used as an ingredient in creep feed to increase calf weight gain was observed by Gelvin *et al*. (2004). As the amount of field pea hay (FPH) was increased *i.e*., 0% (T1), 0.5% (T2) and 0.3% (T3) of body weight of FPH on dry matter basis in the diet of Murrah buffaloes, the body weight increased was found by Hayashi *et al.* (2007). Newman *et al*. (2011) observed that the soybean meal in diets fed to growing-finishing pigs may be replaced by pea chips without negatively affecting growth performance of the animals. However, when the animals are fed with the grazing oat and pea crop residue, the performance was not negatively affected observed by Krause *et al*. (2013). The field pea can replace up to 20% of fiber-based ingredients in weaning transition diets without affecting average daily gain was found by Senturklu and Landblom (2015). Furthermore animals fed the extruded pea diet had a significantly greater average daily gain than those fed the soybean meal diet and also improved growth performance of pigs observed by Tusnio *et al*. (2017).

Effect of pea pods residue feeding on milk production

Valentine and Bartsch (1990) found that milk production was higher for early lactation cows fed peas than for those same cows fed barley. Mustafa *et al*. (2000) reported that pea silage can be used to replace barley silage without affecting milk yield or composition. However, the substitution of peas for soybean and barley, milk yield were not affected was observed by Khorasani *et al.* (2001). There was no negative effect on milk yield and composition of dairy cows when the diet of soybean meal was substituted with flaked peas and faba beans was found by Volpelli *et al*. (2012). Furthermore a part of extruded soybeans replacement with peas (*Pisum sativum*) in dairy cows rations had a negative effect on milk yield but increased milk fat and protein content and also during the experimental period, the amount of urea and lactose in milk, both in control and experimental groups, differed non-significantly (Kudlinskiene *et al*. 2016).

Effect of pea pods residue feeding on body condition score

The effect of feeding pea pods / pea pods residue on body condition score of animals. Poland *et al*. (2004) found that body condition score (BCS) change was improved by supplementation of field pea and sunflower meal as compared to control group on day 42 in year 1st and on day 84 in year 2nd. Parveen *et al*. (2009) reported that all the body measurements *i.e*. body length, chest girth, height at withers and paunch girth of Sahiwal calves of 1 month to 6 months of age showed increase in body dimensions of the calves with the growing age and the BCS is nonlinear, with an optimum calving BCS of 3.0 to 3.25 (5-point scale); lower calving BCS is associated with reduced production and reproduction, whereas calving BCS>3.5 (5-point scale) is associated with a reduction in early lactation dry matter intake and milk production and an increased risk of metabolic disorders reported by Roche *et al*. (2009). Klopcic *et al*. (2011) reported that first the farmer can use the score of the classifier as a reference for his body condition scores and second, the herd book could use the BCS to present trend in the herd in time, which can help the farmer to analyze his feed management. Therefore body condition score is a tool in selecting cows which balance production, fertility and health in the right way. However, the body condition score was higher in crossbred calves fed with high concentrate ration (containing 60% concentrate and 40% sorghum stover) as compared to the calves fed with low concentrate ration (40% concentrate and 60% sorgum stover) was found by Sunetha (2013). Furthermore, the body condition score of crossbred calves fed with low energy ration is lower than the calves fed with high energy ration was observed by Kumar (2015b).

Effect of pea pods residue feeding on haemato-biochemical constituents

Petit *et al*. (1997) reported that there was no difference in serum urea concentration between cows fed raw peas and those fed extruded peas. However, serum urea concentrations were higher for cows fed extruded peas than for those fed with soybean meal. Masoero *et al.* (2006) observed that there were no differences observed among feeding groups on blood parameters except for the cholesterol level which was higher (P<0.05) in animals fed the expanded pea diet. Pea's supplementation had no effects on metabolic blood profile as well as clotting aptitude and also found that the blood level in cows appeared to be decreased by the replacement of soybean with pea in concentrates and there is no significant difference occurred in blood metabolites, electrolytes, or enzymes between control soybean and experimental pea diets was found by Tufarelli *et al.* (2012). However, blood proteins values were comparable between the experimental groups, whereas a slight but significant increase of blood urea was observed in cows fed pea and faba beans as compared to cows fed with soybean meal was reported by Volpelli *et al*. (2012).

CONCLUSION

It could be concluded that utilization of pea pods is the beneficial in enhancing the growth performance, body condition score and also milk production of dairy animals. This is an effective method of utilization of pea waste after extraction of pea grains from pea pods.

Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

Birkelo, C.P., Johnson, B.J. and Rops, B.D. (2000). Field peas in finishing cattle diets and the effect of processing. South Dakota Beef Report. P: 5.

Castell, A.G., Guenter, W. and Igbasan, F. A. (1996). Nutritive value of peas for nonruminant diets. Animal Feed Science and Technology. 60: 209-227.

Collins, C.L., Eason, P.J., Dunshea, F.R., Higgins, T.J. and King, R.H. (2006). Starch but not protein digestibility is altered in pigs fed transgenic peas containing α amylase inhibitor. Journal of the Science of Food and Agriculture. 86 (12): 1894-1899.

Corbett, R., Goonewardene, L.A. and Okine, E.K. (1995). Effects of feeding peas to high-producing dairy cows. Canadian Journal of Animal Science. 75(4): 625-629.

DAHD and F. (2017-18) 19th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India.

FAO, (2011). Grassland Index. A Searchable Catalogue of Grass and Forage Legumes. Food and Agriculture Organization, Rome.

Gdala, J., Buraczewska, L. and Grala, W.(1992). The chemical composition of different types and varieties of pea and the digestion of their protein in pigs. Journal of Animal Feed Science. 1(1): 71-79.

Gelvin, A.A., Lardy, G.P., Soto-Navarro, S.A., Landblom, D.G. and Caton, J.S. (2004). Effect of field pea-based creep feed on intake, digestibility, ruminal fermentation and performance by nursing calves grazing native range in western North Dakota. Journal of Animal Science. 82(12): 3589-3599.

Gilbery, T.C., Lardy, G.P., Soto-Navarro, S.A., Bauer, M.L. and Anderson, V.L. (2007). Effect of field peas, chickpeas and lentils on rumen fermentation, digestion, microbial protein synthesis, and feedlot performance in receiving diets for beef cattle. Journal of Animal Science. 85(11): 3045-3053.

Hayashi, Y., Devkota, N.R. and Kumagai, H. (2007). Effects of field pea (*Pisum sativum* L.) hay feeding on dry matter intake and milk production of Murrah buffaloes (*Bubalus bubalis*) fed rice straw *ad libitum*. Animal Science Journal. 78(2): 151-158.

IGFRI Vision, (2050). Indian Grassland and Fodder Research Institute, Jhansi (UP).

Ipharraguerre, I.R. and Clark, J.H. (2003). Soyhulls as an alternative feed for lactating dairy cows: A review. Journal of Dairy Science. 86(4): 1052-1073.

Khorasani, G.R., Okine, E.K., Corbett, R.R. and Kennelly, J.J. (2001). Nutritive value of peas for lactating dairy cattle. Canadian Journal of Animal Science. 81(4): 541-551.

Klopcic, M., Hamoen, A. and Bewley, J. (2011). Body condition scoring of dairy cows. Biotechnical Faculty, Department of Animal Science. Domzale: 7, ISBN: 978-961-6204-54-5.

Kumar, A., Mondal, B.C. and Tiwari, D.P. (2015b). Effect of phase feeding on growth, body measurements and body condition score in growing crossbred female calves. Indian Journal of Animal Nutrition. 32(3): 280-284.

Krause, A.D., Lardner, H.A., McKinnon, J.J., Hendrick, S., Larson, K. and Damiran, D. (2013). Comparison of grazing oat and pea crop residue versus feeding grass-legume hay on beef-cow performance, reproductive efficiency and system cost. The Professional Animal Scientist. 29(5): 535-545.

Kudlinskiene, I., Gruzauskas, R., Stankevicius, R., Stanyte, G., Klementaviciute, J., Dovidaitiene, G., Dovidaitiene, J., Cernauskiene, A., Miezeliene and Alencikiene, G. (2016). Effects of extruded peas (*Pisum sativum* L.) on dairy cows performance, milk composition and sensory properties. Veterinarija ir Zootechnika. 73(95): 54-61.

Lanza, M., Bella, M., Priolo, A. and Fasone, V. (2003). Peas (*Pisum sativum* L.) as an alternative protein source in lamb diets: growth performances, and carcass and meat quality. Small Ruminant Research. 47(1): 63-68.

Lardy, G.P., Loken, B.A., Anderson, V.L., Larson, D.M., Maddock-Carlin, K.R., Ilse, B.R. and Bauer, M.L. (2009). Effects of increasing field pea level in high-concentrate diets on growth performance and carcass traits in finishing steers and heifers. Journal of Animal Science. 87(10): 3335-3341.

Masoero, F., Moschini, M., Fusconi, G. and Piva, G. (2006). Raw, extruded and expanded pea(*Pisum sativum*) in dairy cows diets. Italian Journal of Animal Science. 5(3): 237-247.

Muehlbauer, F.J. and Tullu, A. (1997). *Pisum sativum* L. In: New Crop Factsheet, Purdue University, Center for New Crops and Plant Products.

Mustafa, A.F., Christensen, D.A. and McKinnon, J.J. (1998). Effects of moist heat treatment on crude protein composition and degradability of field peas. Canadian journal of animal science. 78 (3): 453-456.

Mustafa, A.F., McKinnon, J.J., Ingledew, M.W. and Christensen, D.A.(2000). The nutritive value for ruminants of thin stillage and distillers' grains derived from wheat, rye, triticale and barley. Journal of Science Food and Agriculture. 80(5): 607-613.

Newman, D.J., Harris, E.K., Lepper, A.N., Berg, E.P. and Stein, H.H. (2011). Effects of pea chips on pig performance, carcass quality and composition and palatability of pork. Journal of Animal Science. 89(10): 3132-3139.

NRC, (2001). Nutrient Requirements of Dairy Cattle. 7th Edn. National Research Council, National Academy of Sciences, National Academy Press, Washington, DC., USA.

Parveen, K., Singh, M., Mukherjee, K and Tiwari, S.P. (2009). Body measurements and their association with age in growing Sahiwal animals. Indian Journal of Animal Scence. 79(12): 1226-1228.

Petit, H.V., Rioux, R. and Ouellet, D.R. (1997). Milk production and intake of lactating cows fed raw or extruded peas1. Journal of Dairy Science. 80(12): 3377-3385.

Poland, W., Tisor, L., Smith, C., Transtrom, T. and Bartlett, A. (2004). Utilization of Field Pea and Sunflower Meal as Dietary Supplement for Beef Cows. In Proceedings-American Society of Animal Science Western Section. 56: 295.

Pursiainen, P. and Tuori, M. (2006). Replacing grass silage with pea-barley intercrop silage in the feeding of the dairy cow. 15: 235-251.

Reed, J.J., Lardy, G.P., Bauer, M.L., Gilbery, T.C. and Caton, J.S. (2004). Effect of field pea level on intake, digestion, microbial efficiency, ruminal fermentation, and in situ disappearance in beef steers fed growing diets. Journal of Animal Science. 82(7): 2123-2130.

Roche, J.R., Friggens, N.C., Kay, J.K., Fisher, M.W., Stafford, K.J. and Berry, D.P. (2009). Body condition score and its association with dairy cow productivity, health and welfare. Journal of Dairy Science. 92(12): 5769-5801.

Senturklu, S. and Landblom, D.G. (2015). The Effect of field pea (*Pisum sativum*) replacement in starch-and fiber-based post weaning transition diets for 7.5 month old beef calves and subsequent effect on feedlot finishing performance, carcass quality and net return. Kafkas University Veteriner Fakultesi Dergisi. 21(2): 253-258.

Soto-Navarro, S.A., Encinias, A.M., Bau. L., Lardy, er, M, G.P. and Caton, J.S. (2012). Feeding value of field pea as a protein source in forage-based diets fed to beef cattle. Journal of Animal Science. 90(2): 585-591.

Stein, H.H., Benzoni, G., Bohlke, R.A. and Peters, D.N. (2004). Assessment of the feeding value of South Dakota-grown field peas (L.) for growing pigs. Journal of Animal Science. 82(9): 2568-2578.

Sunetha, S. (2013). Effect of plane of nutrition on nutrient utilization, growth and haematobiochemical constituents in crossbred calves. M.V.Sc. Thesis. G.B. Pant University of Agriculture and Technology Pantnagar, U.S. Nagar, Uttarakhand.

Tufarelli, V., Naz, S., Khan, R.U., Mazzei, D. and Laudadio, V. (2012). Milk quality, manufacturing properties and blood biochemical profile from dairy cows fed peas (*Pisum sativum* L.) as dietary protein supplement. Tierzucht. 55: 132-139.

Tusnio, A., Taciak, M., Barszcz, M., Swiech, E., Bachanek, I. and Skomiał, J. (2017). Effect of replacing soybean meal by raw or extruded pea seeds on growth performance and selected physiological parameters of the Ileum and distal colon of pigs. PloS one. 12(1): e0169467.

Valentine, S.C. and Bartsch, B.D. (1990). Milk production by dairy cows fed legume grains or barley grain with or without urea as supplements to a cereal hay based diet. Australian Journal of Experimental Agriculture. 30(1): 7-10.

Volpelli, L.A., Comellini, M., Gozzi, M., Masoero, F. and Moschini, M. (2012). Pea (*Pisum sativum*) and faba beans (*Vicia faba*) in dairy cow diet: Effect on milk production and quality. Italian Journal of Animal Science. 11(2): 217-222.

Volpelli, L.A., Comellini, M., Masoero, F., Moschini, M., Lo Fiego, D.P. and Scipioni, R. (2009). Pea (*Pisum sativum*) in dairy cow diet: Effect on milk production and quality. Italian Journal of Animal Science. 8(2): 245-257.

Wadhwa, M., Kaushal, S. and Bakshi, M.P.S. (2006). Nutritive evaluation of vegetable wastes as complete feed for goat bucks. Small Ruminant Research. 64: 279-284.

Wenk, C. and Zurcher, U. (1990). Energy utilization by swine of nutritive fiber-rich by-products from the milling and food industry. Archiv fur Tierernahrung. 40(5-6): 423-430.