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ANTI-NUTRITIONAL FACTORS (ANFs) IN VICIA FABA

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SUMMARY : *Recent advances in relation to majır anti-nutritional factors occurring in faba beans (Vicia faba L.) are discussed and their future implications are debated.*

Trypsin inhibitors, lectins and phytates are of less importance compared with tannins, vicine, convicine and dopaglucosides. But, prospects for nutritionally superior cultivars free of tannins and vicine, convicine and dopaglucosides may provide a stimulus for production and utilisation of faba beans as a feed and food stuff.

BAKLADA SAĞLIĞA ZARARLI MADDELER

ÖZET : *Baklada (Vicia faba L.) bulunan sağlığa zararlı maddeler konusundaki son gelişmeler ve bunların gelecek için önemi tartışılmıştır.*

Tannin, visin, konvisin ve dopa-glukosidleri, trypsin inhibitörleri, lektinler ve fitatlara kıyasla dahla fazla öneme sahiptir. Fakat, tannin ve visin, konvisin ve dopaglukositleri ihtiva etmeyen varyetelerin ıslahı baklanın hayvan ve insan gıdası olarak önemini artırmıştır.

Introduction

Faba beans are one of the high yielding protein crops. Development of small seeded cultivars coupled with its strong stems suitable for combining harvest have increased the importence of the species in terms of animal feed stuff. However, the crop along with other legume species contain certain chemical substances that can exert deleterious effects on men and animals when consumed in quantities over a long period (Liener, 1980).

Anti-nutritional factors (ANFs) occurring in faba beans include protease inhibitors, tannins, lectins (Haemagglutonins), vicine and concicine, phytates, saponin, anti-niacin factors and toxic amino acids (Marquardt, 1983; Griffiths, 1984; Hussein and Saleh, 1985; Bond and Smith, 1989). A detailed review of all the ANFs is beyond the scope of this work. But, a brief review of the major ANFs and their

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effects on animal and human organisms, and major advances together with their future potential are discussed.

Protease Inhibitors

Protease inhibitors, more currently known as trypsin inhibitors (TIs) consist of specific protease inhibitors of sulphur rich-low molecular weight proteins in cotyledons and non-specific protease inhibitors of a polyphenolic nature peresent in the seed coats (Griffiths, 1983; Hussein and Saleh, 1985). TIs combine with digestive enzymes (e.g. trypsin), forming tightly bound enzyme/substrate-like complexes (Husein and Saleh, 1985), which uhtimately lead to growth depression of the organism. Protease inhibitors are present in faba beans (Wilson et al. 1972), but at much smaller rates (25-100 units/mg on average) than are found in soya beans (1600-3200 units/mg) Valdebouze et al., 1980; Griffiths, 1983). At these levels they possibly have no serious nutritional significance (Abbey Neal and Norto, 1979). Tannins on the other hand have non-specific trypsin inhibiting properties and occur in the testa. Nevertheless, TIs are themselves rich in methionine and cystine and may have evolutionary advantageous functions such as deterring insect pests (Bond and Smith, 1989).

Lectins (Haemagglutonins)

Lectins are proteins which have the ability to bind to sugar molecules and to agglutinate red blood cells (Liener, 1955). They occur in the cotyledonary fraction of legume seeds (Ward et al. 1977). Evidence suggests that the levels of lectins in faba beans are low when compared to soybeans (Valdebouse et al., 1980) and they are possibly non-toxic or inactivated by the acidity of the stomach (marquardt, 1983). However, lectins also have some physiological (e.g. Rhizobium recognition, see Pusztai, 1991) and defensive (e.g. protecting seeds against Bruchids, see Janzen et al., 1976) functions in plants.

Vicine, convicine and Dopa-glucocide (Dihyroxyphenylalanine)

These glucosides occur mainly in the cotyledons (Marquardt et al., 1981) of faba beans and are believed to be responsible for favism, a haemolytic anaemia found in susceptible individuals following comsumption of fresh or cooked faba beans (Mager et al., 1980). There is evidence also that these glucosides have deleterious effects on animals especially in laying hens whose egg-weight is depressed (Muduuli et al., 1982). The potential practical problem with these glucosides in that they are

heat resistant (Olaboro et al., 1981). However, in practice commercial diets containing excessive levels of such glucosides are not common (Simpson, 1983). Furthermore, a faba bean line without glucosides has already been identified (Duc et al., 1989) and this character is expected to be trnasferred to high yielding cultivars.

Phytates

Plant phosphorous is often found in the form of phytate or phytic acid which form chelate salts with metal ions, and comsequently reduces the amount of phosphorus and associated metal ions available for absorbtion in the intestinal tract (Husein and Saleh, 1985; Wise, 1988). Phytates are present in the cotyledons and seed coats of faba beans (Griffiths, 1983), but at no higher levels than that found in other crops such as soya beans, wheat and rape seed (Maga, 1982) and therefore they possibily do not seriously affect nutritional value (Marquardt, 1983).

Since mineral supplementation in commercial animal feed stuff is common practise (Griffith, 1983) and prospects for the use of plant or microbiological phytates have emerged (Jongbloed et al., 1991; Simons et al., 1990), the importance of phytates is comparatively small for animal nutrition. However, they may limit the utilization of faba beans as protein isolates for human comsuption (Griffiths, 1983).

Tannins

Tannins are present in the testa of faba beans in significant quantities (Marquardt et al., 1974) and are considered to be one of the most important ANFs.

Faba bean tannins adversely affected duckling growth, egg production in poultry and nitrogen digestibility (Aramananious et al., 1973) and reduced live-weight gain in chicks (Ward et al., 1977).

Tannins bind with carbohydrates (Swain, 1965a) and with metal ions (Srikantia, 1976), and more importantly inactivate digestive enzymes (Huisman and van der Poel, 1989). They also damage gut cells (Bernays et al., 1989) and are responsible for astringent taste (Marquardt, 1983) due to a cross-linking between tannins and proteins and glycoproteins (Goldstein and Swain, 1965). Tannins as an ANF limit the wide spread use of faba beans. The combined effect of tannins with concentrations of several other ANFs could further reduce the nutritional value of faba beans as an animal feed stuff (Marquardt et al., 1976).

Although decortication (Marquardt et al., 1975), Soaking, germinating (Rahma et al., 1987) and autoclaving seed (van der Poel et al., 1991) or inclusion of metabolic detoxification agents such as NaOH and Methionine (Garrido et al., 1989)

reduce the harmful effect of tannins, these may be practical only for human comsumption or experimental purposes (Marquardt, 1983). Breeding zero-tannin cultivars (NIAB, 1992) permanently eliminated tannins from the seed. Introduction of new nutritionally superior cultivars has enhanced the attractiveness of the faba bean crop as an animal feed stuff by not only improving anti-nutritional properties but olsa by lowering crude fibre and lignin contents (Bjerg et al., 1984; Garrido et al., 1989). Increasing emphasis on ANFs (Vos, 1989) and recent EC support for efforts towards reducing the dependency on imported protein sources stimulated research on faba beans. This interest may provide necessary stimulus for stagnant faba bean production not only in Europe but olsa in Mediterranean regions.

Conclusion

Faba beans contain certain anti-nutritional factors that have restricted their widespread use as a food and feed stuff. Tannins, vicine, convicine and dopa-glucosides are of more importance compared with trypsin inhibitors, lectins and, phytates. But, recent advances in breeding nutritionally superior cultivars voidof tannins, vicine, voncicine and dopa-glucosides could provide a stimulus for production and utilisation of faba beans as a feed and food stuff.

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