The Identification of Various Species of Bean which may be used in the Manufacture of Meal.

BY

ALEXANDER NELSON AND J. M. MUNRO

DEPARTMENT OF AGRICULTURAL BOTANY,

UNIVERSITY OF EDINBURGH.

With Two Text Figures.

It has become important to be able to identify easily and quickly any possible constituent of meal made from beans. The Fertilisers and Feeding Stuffs Regulation of 1932 made under the Fertilisers and Feeding Stuffs Act of 1926, both of which are now current, gives the "implied definition of 'Bean Meal' as the meal obtained by grinding commercially pure beans of the species (1) *Vicia Faba* (syn. *Faba vulgaris*) or any of its varieties commonly known as 'horse bean,' 'field bean,' or 'broad bean'; or (2) *Phaseolus vulgaris*, the 'true haricot bean' or any of its varieties, white or coloured."

It is quite common for beans of other species to be imported into this country from overseas, and, although these may be ground and sold by millers, they may not be labelled or sold as "bean meal" nor may they be mixed with "bean meal" as defined in the regulations.

Of one at least of the species (*Phaseolus lunatus*—known by various local varietal names such as Burma bean, etc.) different samples often contain varying quantities of glucoside which when hydrolysed yield Prussic or Hydrocyanic acid. Depending on the glucosidal content of the bean this highly active poison may appear in dangerously large quantities and has been reported as a cause of cattle deaths on a number of occasions (J. Min. Ag. 1906, Mar. and Apr., Dunstan 1908). A writer in the Journal of the Ministry of Agriculture (April 1906) points out that soaking or cooking the beans, or the meal made from them, does not necessarily render samples of a high glucosidal content safe for feeding. A certain proportion of cyanogenetic glucoside may occur in beans and yet not render them dangerous to stock. What is a safe limit in this regard must, of course, depend on the nature of the ration fed, but the French Government quoted in the Kew Bulletin Add. Series, ix pt. 2 puts the figure at 0.02% of prussic acid. It is stated by Long (1927) that the cultivated varieties of India and Madagascar are usually quite safe though seeds are dangerous if collected from the wild, as sometimes happens. Further, the same author says that while there is no definite connection between seed

coat colour and glucoside content coloured seeds tend to have a higher content than white seeds. Indeed white beans seem rarely if ever to contain a dangerous amount of the poisonous principle. As there is no significant difference in feeding value between the various species of *Phaseolus* apart from glucoside content (McCandlish 1926) there seems no reason why they should not all be used for feeding provided the meal contains not more than 0·02% prussic acid.

Before the beans are ground there is little difficulty in recognising the species which may be used in meal which will conform to the legal description "bean meal" and those which may not be used. These external differences are described in the Bulletin of the Imperial Institute (1917). Such species as *Phaseolus Mungo, P. Mungo var. radiatus, P. calcaratus,* and *P. angularis* appear rectangular in profile as compared with the flattened kidney-shaped appearance of *P. vulgaris* and *P. lunatus.* These first mentioned species are recognised by difference of colour, size, etc. *Phaseolus lunatus* and *P. vulgaris* can be distinguished by the lines on their seed coats. In the former they radiate from the hilum towards the edge, while in the latter they are irregularly distributed.

This study was specially directed towards methods of identifying the one or more species from which any meal might have been ground. All samples of bean meal contain small pieces of seed coat not completely pulverised, and, while these retain their characteristics, superficial examination does not permit of an exact identification; more detailed and exact methods are necessary.

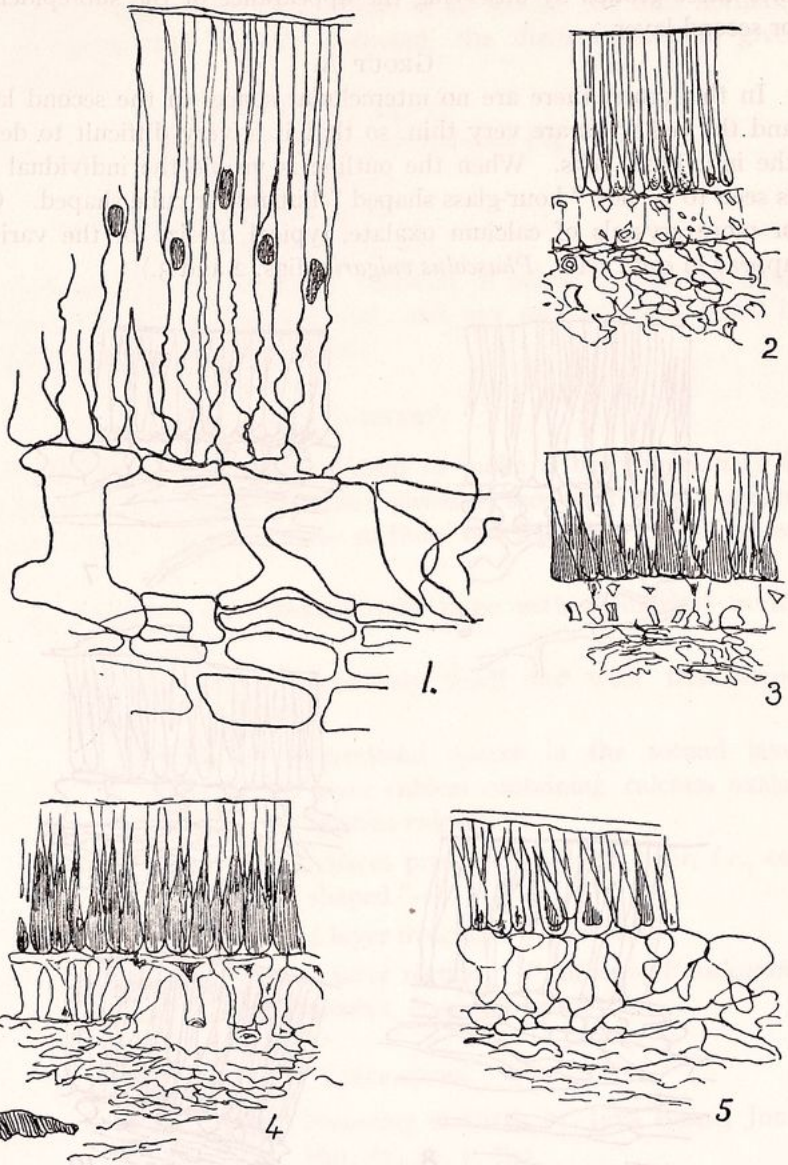
The material used in the work to be described consisted of samples of the undernoted species obtained from the Imperial Institute through the agency of the Regius Keeper of the Royal Botanic Garden, Edinburgh. To the officers concerned we take this opportunity of recording our thanks.

Phaseolus aconitifolius Jacq.
P. angularis Willd.
P. calcaratus Roxb. Two varieties Brown and Black.
P. Mungo Linn.
P. Mungo var. radiatus Linn.
P. lunatus Linn. (5 samples.)

In addition, twelve samples of *P. vulgaris,* all of different varieties, were obtained by purchase from commercial seed houses.

The methods adopted were as follows. As the seed coat is the most permanent portion of the seed and least affected by the milling processes, particular attention was paid to it. The seed coat or a portion of it was stripped off and soaked for an hour to soften it and permit of easy section cutting. The soaked seed coat was supported by pith or carrot tissue and sections cut freehand. The sections so obtained may be examined at once, but details become clearer after staining. After some preliminary trials a very simple technique of

staining was adopted. The sections were immersed in a 5% solution of Cotton Blue in Lactic Acid for five minutes, transferred to a small drop of water on a slide and then mounted in glycerine jelly.



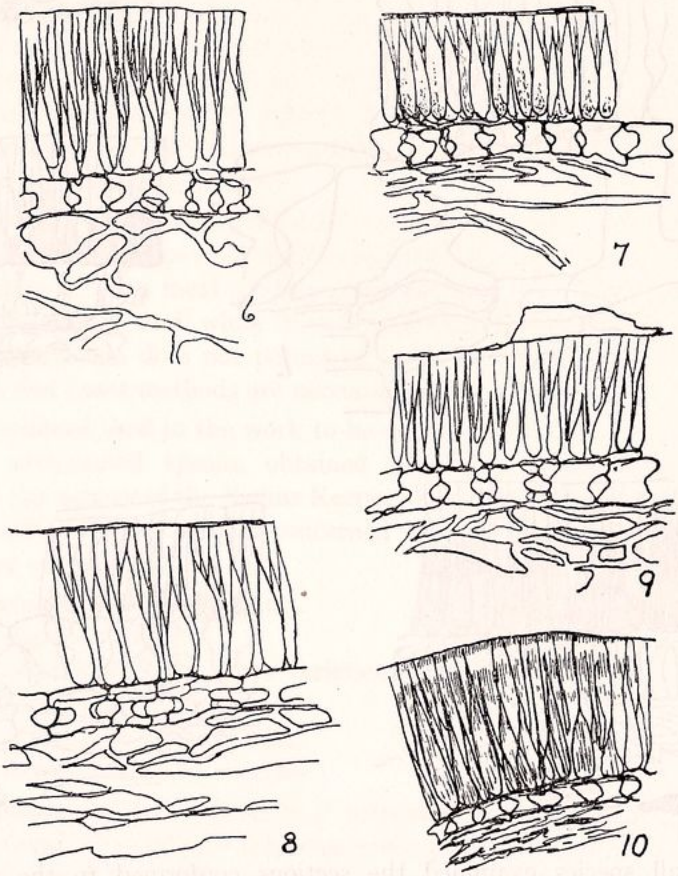
In all species examined the sections conformed to the general structure found in *Leguminosae,* consisting of an outer layer of radially elongated cells with thickened walls (the palisade layer); a definite layer of sub-epidermal cells (hour-glass cells) and finally a layer not clearly organised. From differences in detail of these layers it is possible to identify the various species. The seed coat of *Vicia Faba* (fig. 1) is quickly differentiated from *Phaseolus spp.* by the typical appearance of the palisade and also by the relative largeness in size of the individual cells. The cavity of the palisade

cells of the species of *Phaseolus* as noted by Harz (1885) and Guignard (1906) is flask-shaped narrowest towards the exterior of the seed.

Within the genus of *Phaseolus* it is possible to separate the species into three groups by observing the appearance of the sub-epidermal or second layer.

GROUP A.

In this group there are no intercellular spaces in the second layer and the cell walls are very thin, so that it is very difficult to define the individual cells. When the outline is visible the individual cell is seen to be not "hour-glass shaped" but rather cube shaped. One or more crystals of calcium oxalate, typical in size of the variety, appear in each cell. *Phaseolus vulgaris* (figs. 2 and 3.)



GROUP B.

Here the cells of the second layer are definitely shaped like the old-fashioned hour-glass. The cells are large at either end, the middle portion being narrow. This structure provides large inter-cellular spaces. It is to be noted that the appearance of this layer is not regular as will be found in Group C described below. In section the cells of Group B appear to be canted over in all directions irregular as is clearly shown in figures 4 and 5. *Phaseolus lunatus.*

GROUP C.

In this case the cells of the second layer are definitely hour-glass shaped but regular in appearance. Even in sections from the seed coat at the edge of the seed, where in all species the cells normally are elongated and a little distorted, the distinctions here given are constant.

Phaseolus Mungo (fig. 7).
Phaseolus Mungo var. radiatus (fig. 9).
P. calcaratus (fig. 8).
P. angularis (fig. 6).
P. aconitifolius (fig. 10).

Owing to lack of authentic material of other species this must be regarded as a preliminary note, and any such material would be welcomed to confirm these results.

SUMMARY.

Species which have been ground to make a bean meal may be identified by sectioning the small pieces of seed coat always present in such meals. In transverse sections the following characters are seen :—

(1) Palisade cells comparatively large with cylindrical cavity. *Vicia Faba.*

(2) Palisade cells comparatively small and with flask-shaped cavity—

(*a*) With no intercellular spaces in the second layer. Cells of this layer cubical containing calcium oxalate crystals. *Phaseolus vulgaris.*

(*b*) Intercellular spaces present in second layer, *i.e.*, cells " hour glass shaped "—

(i) second layer irregular. *P. lunatus.*

(ii) second layer regular. *P. Mungo, P. calcaratus, P. angularis, P. aconitifolius.*

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DESCRIPTION OF TEXT FIGURES.

Transverse sections of seed-coat (all × 450).

Fig. 1. *Vicia Faba* (Horse bean).
,, 2. *Phaseolus vulgaris* (Commercial Haricot bean).
,, 3. *Phaseolus vulgaris* (Runner bean " Veitch's climbing ").
,, 4. *Phaseolus lunatus* (Awije bean).
,, 5. *Phaseolus lunatus* (White Rangoon).
,, 6. *Phaseolus angularis*.
,, 7. *Phaseolus Mungo*.
,, 8. *Phaseolus calcaratus*.
,, 9. *Phaseolus Mungo var. radiatus*.
,, 10. *Phaseolus aconitifolius*.