

PRODUCTION OF COTTONSEED FLOUR FOR HUMAN CONSUMPTION

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Protein, fat, hull, meat and gossypol contents of eight Pakistani varieties of cottonseed have been determined. Direct utilization of undecorticated cottonseed cakes for the production of protein-rich flour has been shown to be feasible. The flour so obtained is free from active gossypol and contains 50-55% proteins. Comparative suitability of the cottonseed varieties to be used for the production of the flour economically has been discussed.

Cottonseed, of which the supply is abundant in some countries, can be an effective source of protein supplement.¹ U.N.I.C.E.F. and F.A.O. have a programme of introducing cottonseed proteins in the human dietary requirements of different countries of the world in which a large proportion of their populations suffers from malnutrition due to the deficiency of proteins. Countries of South East Asia and Middle East fall in a region where cottonseed proteins can be a useful dietary supplement.

There are many factors which prevent the use of cottonseed proteins in the human diet. Gossypol and fibrous materials such as lints and hulls must be removed before cottonseed proteins could be put to human use. Large number of workers in different countries have made food preparations which include cottonseed flour blended with other vegetable proteins.^{2,3} Of special interest are 'Incaprina' which contains cottonseed flour to the extent of 30% and 'Allison' flour produced in the U.S.A. which provides a nutritious material when mixed with wheat.³⁻⁶

One of the difficulties encountered in the case of countries like Pakistan and India is that the proper type of raw material from which cottonseed flour suitable for human consumption can be manufactured is not available. Here crushers and processors lay main emphasis on the extraction of oil and almost the whole of the cake is used as animal feed.^{7,8} While expressing oil from cottonseeds, decortication and delinting are generally not undertaken. In view of the high fibre contents of the cake thus produced, it is not very suitable for manufacturing an edible product from it. During crushing of the cottonseeds no consideration is given to the removal or denaturation of gossypol, the percentage of which varies with the varieties of cotton.

Proteins in cottonseeds vary from variety to variety. On the average, however, it is about 20%. On a comparative basis, cereals contain hardly more than 12% proteins. Pakistan produces a number of varieties of cottonseeds, chief

among which are the following eight: L-11, L-9, F-124, F-199, AC-180, AC-257, AC-184, and AC-134. Samples of these varieties were obtained and analysed with respect to their contents of proteins, fats, hulls, meats and total gossypol.

This paper deals with a process of manufacturing edible cottonseed flour directly from the cakes as they are available in the market. It also enables the total removal of active gossypol from the final product.

Methods of Analysis

Eight varieties of cottonseed such as L-11, L-9, F-124, F-199, AC-180, AC-257, AC-184 and AC-134 were obtained through the courtesy of the Assistant Marketing Officer, West Pakistan, Lahore. Cottonseed cakes were purchased locally from the market.

Estimation of Hulls and Meats in Seeds.—Few grams of seeds were bisected individually with the help of a scalpel. Meats were picked out of the hulls with the help of a sharp needle and weighed. The hulls free from meats were weighed separately.

Total Gossypol.—This was determined according to the methods of Podol'skaia⁹ and Royce, Harrison and Dean¹⁰ with some modification introduced by us as follows:

Thirty grams of cottonseed of each variety was crushed and extracted for 18 hours, in Soxhlet extractors with chloroform till the pigment was no longer extractable. The chloroform extract was filtered through Gooch crucible and the solvent evaporated entirely at 60°C. The extract was treated with 10 ml. naphtha (60-100°C.), 2 ml. pyridine, 1.5 ml. aniline, mixed well through swirling and allowed to stand for 3 to 4 days at room temperature.

The precipitate of dianilino-gossypol-dipyridine was collected in an already weighed crucible, rinsed and washed with naphtha containing 2-3%

pyridine. The precipitate was dried for 2 hours at 60°C. in an oven and the weight of the precipitate was multiplied by a factor of 0.627 to convert it to gossypol.

Determination of Gossypol.—Nearly all the methods for the determination of gossypol are based on the extraction of gossypol from the seeds or meals with diethyl ether and its subsequent determination in the form of dianilino-gossypol-dipyridine. The number of modifications of this method which have been proposed suggests that none of them is satisfactory. We selected the procedure of Podol'skaia⁹ and Royce, Harrison and Dean¹⁰ but employed chloroform instead of ethyl ether as solvent for gossypol extraction. Ethyl ether is known to contain peroxides which destroy gossypol during extraction. Chloroform is free from such contaminants and gossypol is extracted quite efficiently as with diethyl ether. We have observed that the precipitation of dianilino-gossypol-dipyridine is complete within 4 days even if the concentration of gossypol in the seeds is below 0.1%. Keeping the filtrate for 7 to 14 days as suggested by the above named authors does not produce any further precipitation of dianilino-gossypol-dipyridine.

Flour totally free from active gossypol has been prepared by us by giving it one or two washings, with hot 95% alcohol. This treatment also raises the percentage of protein in the final product from 50 to 55% and improves the colour as well.

Table 1 shows the percentage of hulls and meats in different Pakistani varieties of cottonseed. The bisection method (see Methods of Analysis) introduced by us gives very accurate estimations of hulls and meats in the seeds because it does not allow intermixing of the two which usually occurs

Analytical Results and Discussion

TABLE 1.—PERCENTAGE OF HULLS AND MEATS IN DIFFERENT COTTONSEED VARIETIES.

Variety	Hulls %	Meats %
F-19	46.62	53.38
F-124	47.43	52.57
L-9	56.53	43.47
L-11	46.43	53.57
AC-184	48.54	51.46
AC-257	50.17	49.83
AC-180	53.98	46.02
AC-134	46.03	53.97

in other methods involving crushing and sieving. Table 1 also shows that varieties F-199, L-11 and AC-134 contain higher percentages of meats which is one of the important determining factors for the quality and yield of the cottonseed flour.

Table 2 shows the composition of different cottonseed varieties. It is clear from this table that from the point of view of protein contents and hence for the preparation of protein-rich flour, varieties L-11 and AC-134 are very suitable.

TABLE 2.—COMPOSITION OF DIFFERENT COTTONSEED VARIETIES.

Variety	Hulls %	Oil %	Protein %
F-199	46.6	20.6	18.3
F-124	47.4	21.6	17.2
L-9	56.5	16.9	16.0
L-11	46.4	18.2	21.2
AC-184	48.5	22.5	19.0
AC-257	50.1	19.4	18.0
AC-180	53.9	18.1	17.7
AC-134	46.0	22.2	20.0

Table 3 shows that AC-134 is particularly suitable for the production of edible flour because in addition to having high oil and protein percentage, it contains exceptionally low content of gossypol.

TABLE 3.—PERCENTAGE OF GOSSYPOL IN COTTONSEED VARIETIES.

Variety	In whole seeds %	In meats %
F-199	0.218	0.40
F-124	0.266	0.50
L-9	0.179	0.411
L-11	0.218	0.40
AC-184	0.277	0.537
AC-257	0.252	0.505
AC-180	0.136	0.250
AC-134	0.062	0.120

Process for Producing Flour

The cottonseed cakes obtained after oil has been extracted from seeds (17-20% protein) were crushed in a hammer mill. The resulting mixture of hulls, lints and protein matter was passed through 180 mesh vibrating screens which separated flour from the mixture. The flour was then treated

with $1\frac{1}{2}$ times volume of boiling 95% ethanol for 3 minutes. The alcohol was then removed by filtration under suction and the residue was washed with one volume of 95% alcohol. It was then dried in hot air. The used alcohol containing gossypol and other materials was circulated again and again through fresh flour 4 to 5 times. The alcohol was then recovered by distillation. It is economical to use whole cottonseeds for preparing cottonseed flour because oil will be a by-product which will considerably help in lowering the cost of flour. The protein content of the flour thus prepared is between 50-55%. Solubility of nitrogen of the flour in 0.02N alkali solution is 67-70%. The flour contains perceptibly no free gossypol and has yellow colour. It has flavour somewhat similar to cereals and can be stored like other cereal flour.

Acceptability trials conducted in the laboratory showed that this flour can be incorporated in wheat to the extent of 10% without changing the palatability of the bread.

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