# GLUTAMIC ACID

## Part II.—Glutamic Acid from Oil Cakes

MUHAMMAD ASHRAF* AND KARIMULLAH†
*Institute of Chemistry, University of the Panjab, Lahore*

( Received August 18, 1960 )

There is an abundance of various oil cakes in Pakistan. The authors have carried out investigation on different oil cakes with respect to their glutamic acid content. It has been found that glutamic acid, glutamic acid hydrochloride and monosodium glutamate can be produced with maximum yield from rapeseed, cottonseed and linseed oil cakes. The technique of the production is quite easy and makes use of chemicals mostly available in Pakistan.

In Part I[1] of the present series of papers on the production of glutamic acid in Pakistan, various sources from which the acid can be manufactured, were enumerated. In the previous communication it was mentioned that oil cakes constitute an easily accessible and abundant source for the production of glutamic acid. The production of glutamic acid alone from food-grains would not be possible economically in view of the current food shortage in the country. If, however, the acid is produced as a by-product of the starch industry in Pakistan, the utilization of food grains for its production would not only be justifiable but desirable also. The earlier paper emphasised this point particularly.

However, various oil cakes are available in large quantities in Pakistan. At present they find little use as a human food. They are mainly consumed as animal feed and are also sometimes used even as fertilizers. An idea as to the quantity of the various oil cakes that are available in the country can be gained from Table 1. The data in the table were compiled from the figures for the production of various oil seeds for 1958 in both East and West Pakistan.[2]

The abundance of the various oil cakes in the country is thus quite clear. Their effective utilisation in itself calls for investigations. The proteins of these oil cakes can be recovered and used in fortification of protein-deficit diet. These proteins can also be employed for the production of several essential amino acids. Glutamic acid is one such essential acid.

In view of the value of glutamic acid both as an essential amino acid as well as a food adjunct, a study of its production from oil cakes in Pakistan was thus considered most desirable. Investigations were carried out on different oil cakes with respect to their glutamic acid contents. At the same time the production of the acid by cheap and economically workable methods was also studied. These studies are presented in the present paper.

TABLE 1.—PRODUCTION FIGURES OF IMPORTANT OIL SEED CAKES OF PAKISTAN (1958).

| Oil cake | W. Pakistan | E. Pakistan | Total |
|---|---|---|---|
| Rape & mustard | 123581 tons | 50685 tons | 174266 tons |
| Cotton | 432915 ,, | 3822 ,, | 436737 ,, |
| Linseed | 1299 ,, | 7148 ,, | 8447 ,, |
| Sesamum | 2340 ,, | 12636 ,, | 14976 ,, |
| Castor | 1656 mds. | 20460 mds | 22116 mds. |
| Ground-nut | Almost entire supplies are used as nuts. | | |

### Materials

*Oil Cakes.*—Data in Table 2 have been given in order to compare the glutamic acid content of various oil cakes. It is observed that cottonseed

TABLE 2.—GLUTAMIC ACID CONTENT OF SOME OIL CAKES.[3]

| Oil cake | Glutamic acid % |
|---|---|
| Groundnut | 7.8 |
| Cottonseed | 7.5 |
| Hempseed | 6.4 |
| Sunflower | 5.2 |
| Castor | 5.6 |
| Cocoanut | 5.0 |
| Linseed | 3.8 |

* Now at the Department of Pharmacy, University of the Panjab, Lahore.

† At West Regional Laboratories, Pakistan Council of Scientific and Industrial Research, Lahore.

cake has almost the same content of glutamic acid as soya-bean meal. But the percentage of glutamic acid available from mustard cake was found, in our investigations, to be the highest. As both rapeseed and cottonseed oil cakes constitute by far the largest quantity of oil cakes available in the country, these can go a long way to meet the requirements of glutamic acid production in Pakistan. Soya-bean meal is employed for similar purposes in other countries. Three main oil cakes used in these investigations were procured locally from the market.

## Methods

The methods for the production of glutamic acid hydrochloride, glutamic acid and mono sodium glutamate were developed after a good deal of experimental work to give the maximum yield of these products. These methods are indicated as follows.

(*i*) *Glutamic Acid Hydrochloride.*—One hundred g. oil cake, 300 ml. hydrochloric acid (sp. gr. 1.14), and 1 g. tin were refluxed at 107-110°C. in one litre round-bottom flask for 12 hours. Afterwards the contents of the flask were allowed to cool to room temperature and filtered. The flask was washed with 15 ml. of concentrated hydrochloric acid, which was further used for washing the residue on the filter. The filtrate was boiled with 20 g. of activated animal charcoal for 15 minutes. The mixture was cooled to about 60°C. and then filtered. The filtrate obtained was again treated with 10 g. of the activated animal charcoal as before. The mixture was filtered out once again.

The filtrate was concentrated under reduced pressure (18 mm./40-45°C.) to about 150 ml. The concentrate was allowed to stand overnight in a refrigerator for the crystallisation of glutamic acid hydrochloride. Next day, the crystals formed were removed by filtration. The mother liquor was further concentrated to about 75 ml. and cooled to get an additional crop of the crystals. The two lots of the crystals were combined and recrystallised from hydrochloric acid solution. The final crystals were dried and weighed.

(*ii*) *Glutamic Acid.*—The crystals of glutamic acid hydrochloride were dissolved in a minimum quantity of hot distilled water. The pH of the solution was brought to 3.2 by the addition of sodium carbonate solution. The final solution was kept aside for 72 hours in a refrigerator for the crystallisation of glutamic acid. The crystals of glutamic acid formed in the solution were subsequently filtered. These crystals were washed with ice cold water until free from sodium chloride. The mother liquor and the washings were combined and concentrated to obtain an additional yield of glutamic acid. The two crops of crystals were combined, dried and weighed.

(*iii*) *Monosodium Glutamate.*—The glutamic acid thus obtained was dissolved in water. The solution was brought to a pH of 5.4 to 6.2 by the addition of sodium carbonate solution. The resultant solution was concentrated under reduced pressure to obtain monosodium glutamate. The concentrate on cooling gave monosodium glutamate in the powder form. This product was filtered, dried and weighed.

TABLE 3.—YIELD OF GLUTAMIC ACID HYDROCHLORIDE, GLUTAMIC ACID AND MONOSODIUM GLUTAMATE UNDER DIFFERENT CONDITIONS.

| Oil-cake | Time | Sp. gr of acid | % of glutamic acid hydrochloride | % of glutamic acid | % of monosodium glutamate |
|---|---|---|---|---|---|
| Mustard | | | | | |
| (1) | 6 hrs. | 1.18 | 10.6 | 6.5 | 8.0 |
| (2) | 12 ,, | 1.14 | 11.0 | 6.8 | 8.62 |
| Linseed | 12 ,, | 1.14 | 6.11 | 3.7 | 4.37 |
| Cotton | 12 ,, | 1.14 | 5.44 | 3.5 | 4.4 |

## Discussion

The yeilds of glutamic acid and its products obtained have been summarized in Table 3. In this table are also indicated various conditions of hydrolysis of the oil cakes. It is noted that maximum yields of the amino acid and its products are obtained when conditions outlined in the methods are closely followed.

Production of glutamic acid invariably begins with hydrolysis of proteinous materials containing the acid. Hydrolysis can be brought about either enzymatically or with an acid or an alkali. At present, acid and alkali hydrolyses are largely employed. The acid hydrolysis is generally preferred and hydrochloric acid[4] is probably the best hydrolyzing agent. It is especially employed in the production of glutamic acid to be used for food purposes.

Protein hydrolysates made with sulphuric acid[5] as the hydrolyzing agent are not generally acceptable for food purposes, principally because of their inferior taste and high cost of production.

Protein hydrolysis in an alkaline solution[6] results in the formation of racemic glutamic acid. Alkaline hydrolysis is, nevertheless, used satisfactorily in the commercial manufacture of monosodium glutamate from Steffen's waste.

An excess of hydrochloric acid for hydrolysis should be avoided. The use of too much of the acid results in the formation of excessive quantities of sodium chloride which probably exerts an influence on the hygroscopicity of the final product in the powder form.[7]

In the present investigations it was found that hydrochloric acid of 1.03-1.14 specific gravity gives the best yield when the hydrolysis is conducted for 12 hours. Higher concentrations of the acid become troublesome during concentration and filtration of the hydrolysates.

During concentration of the hydrolysate under reduced pressure the distillate gives intenser meaty odour than that of the residual solution or even the crystals of monosodium glutamate. This odour might be due to amino acids other than glutamic acid present in the distillate. The hydrolysate which is always coloured, can be decolourised by the treatment with activated carbon. However, on concentration a slight colouration returns.

## Conclusion

Glutamic acid, glutamic acid hydrochloride and monosodium glutamate can be produced with maximum yield from rapeseed, cottonseed and linseed oil cakes. The methods employed for the production of these materials have been so worked out as to make use of chemicals which are mostly available in Pakistan. The techniques of the production are quite easy and do not involve complicated procedure and equipment. With the production of essential amino acids, particularly gultamic acid from oil cakes another waste of Pakistan, rich in proteins, can thus be effectively utilised.

## References

1. Muhammad Ashraf and Karimullah, Pakistan J. Sci. Ind. Research, **1**, 76, (1958).
2. The Department of Agriculture, West Pakistan, private communication.
3. B. V. Ramachandran, Current Sci. (India), **22**, 195 (1953).
4. A. H. Forest, U. S. patent 2,463,877 (March 8, 1949).
5. A. H. Lloyd, *Proceedings of the Symposium on Monosodium Glutamate*, (Chicago, 1948) p. 54.
6. D. V. Manning and B. F. Buchaman, i·id., p. 16, (1948).
7. A. H. Lloyd, Food Inds., **18**,808 (1946).