Editorial

Niacin-Tryptophan Relationships in the Development of Pellagra

Although it is now generally recognized that tryptophan can cure pellagra—and it is interesting to recall that Goldberger and Tanner produced such a cure in 1921[1]—the quantitative relationship of tryptophan and niacin to this end have not been known. Why should Goldberger's[2,3] and Goldsmith's[4] maize diets have produced pellagra and why did the wheat diets of Goldsmith and of the Elgin studies[5] result in no symptoms of pellagra? And why, again, should there be no significant incidence of pellagra in rural Central America,[6] an area where corn with 10 per cent moisture is consumed in amounts as high as 500 gm per day?

Recent studies at Elgin State Hospital on the relative effects of deficiencies of niacin and tryptophan have produced some interesting results which may lead to the better understanding of the so-called pellagragenic properties of corn. Although pellagra was not produced and no appreciable amounts of corn were used in this Elgin project, the data obtained, when considered together with those reported by others, make possible some valuable interpretations.

Three different groups received the same basal diet for almost two years; one group without supplement, one supplemented with 10 mg niacin, and another group with 100 mg tryptophan. By comparing urinary excretions of N^1-methylnicotinamide with the intake of niacin precursors it was possible to make estimates of the relative efficiency with which niacin and tryptophan produced N^1-methylnicotinamide. A ratio of approximately 1:60 was obtained in comparing data from the three experimental groups. This was confirmed when 10 gm of a commercial lactalbumin, providing 200 mg of tryptophan, was given to some subjects from each group.

It is apparent to any investigator that it is not reasonable to assume an inflexible relationship between tryptophan and niacin consumption which could be maintained through all genetic and dietary variations; but it is not unreasonable to make an approximation such as has been suggested in order to facilitate calculations of niacin equivalents. Whether or not the ratio should remain at 1 to 60 will, as with other nutritional standards, need additional evaluation. The data about to be published supporting this ratio are not statistically incontrovertible, as only 30 subjects were involved, but the arithmetical averages obtained do provide a point of reference sufficient for present use. Some support for choosing 60 as the weight in mg of tryptophan equivalent to 1 mg of niacin in human diets can be obtained from the work of Krehl, Sarma, Tepley, and Elvehjem,[7] who showed that in rats 1 mg of niacin in 100 gm of diet could be replaced by 50 mg of tryptophan.

The basal diet in the Elgin study provided 5.8 mg of niacin and 265 mg of tryptophan (considerably less than the estimate of 6.7 mg of niacin and 300 mg of tryptophan in the Goldberger diet). However, the Elgin diet provided only 2300 calories, whereas Goldberger's subjects needed about 3000 calories to replace their energy expenditures. If 60 mg of tryptophan are given a niacin equivalence of one and a calculation is made for the equivalents per 1000 calories, one obtains figures of

4.43 for the Elgin diet and 3.90 for the Goldberger diet. Similar calculations for Goldsmith's "corn" diet (which provided 4.7 mg niacin, 190 mg tryptophan, and approximately 2000 calories), and for Goldsmith's "wheat" diet (which provided 5.7 mg niacin, 230 mg tryptophan, and approximately 2000 calories), give figures of 3.93 and 4.77 niacin equivalents, per 1000 calories, respectively. From this one may summarize that pellagra developed at niacin equivalents of 3.9 but was not apparent at 4.7.

The same calculation cannot be made for the high corn diet used in Central America because of lack of specific information about caloric consumption. Aguirre, Bressani, and Scrimshaw[6] have indicated that the average corn consumption by the Guatemalan Indian is on the order of 500 gm per day. Taking into consideration all corn varieties that they analyzed, this amount would provide an estimated average of 8.8 mg of niacin and 227 mg of tryptophan from corn alone, amounts unlikely to be pellagragenic even on a diet of 2500 calories. This leads to the obvious conclusion that if corn is a sufficiently large proportion of a diet, pellagra will not develop! One should, however, be careful to point out that though corn in sufficient proportions may prevent pellagra, it is not adequate in amino acid composition to preclude other nutritional disorders.

If our suggestions regarding "niacin equivalents" should be valid, then the replacement of about half the corn in the Central American diet with sweet potatoes, corn syrup, corn starch, or other carbohydrate foods, low in protein, should markedly increase the incidence of pellagra in that part of the world. Conversely, if about half the protein foods in a marginal North American diet with little animal protein is provided by corn, then this diet would be pellagragenic if fed for four months or longer.

As very large percentages of corn in diets are less pellagragenic than diets with half as much corn, there seems to be little justification for the practical consideration of a "toxic factor" in corn. This elimination of the "toxic factor" does not exonerate corn as the culprit in human pellagra, because, without corn, it is difficult to conceive of a practical diet that has sufficient calories and protein for minimal maintenance and has a niacin equivalence of less than 5.0. The alcoholic who develops pellagra ingests many calories and takes in little protein of any kind.

The implication that more corn (and less carbohydrate) will prevent pellagra should provide a basis for some interesting investigations.

At this point it may be pertinent to note that cow's milk is low in niacin,[8] 1.21 mg per 1000 calories, but high in tryptophan,[9] 673 mg per 1000 calories, and that human milk in comparison has 2.46 mg of niacin and 443 mg of tryptophan per 1000 calories, respectively.

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