DETOXIFICATION AND UTILIZATION OF WILD YAM (*Dioscorea hispida* Dennst.) FLOUR AS BINDER IN MEAT LOAF

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ABSTRACT

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Wild yams (*Dioscorea hispida* Dennst.), locally known as *nami* or *kot*, was detoxified and processed into flour. Detoxification was carried out by salting thinly-sliced tubers and subsequently washing these under running water. Results showed that detoxification can be achieved either by treating the thin slices with low salt concentration and washing with water for a long period of time or by treating the thin slices with a high salt concentration followed by a shorter washing period.

Substitution of corn starch with yam flour in meat loaf formulation resulted in lower cooking losses and volume of drippings. Sensory evaluation of the meat loaf showed an improvement in crumbliness, juiciness and general acceptability.

KEY WORDS: Binder. Detoxification. Dioscorine. *Nami* or *kot*. Wild yam.

INTRODUCTION

The widening gap between the world's food supply and population growth is a problem that requires utmost concern. Hence, an agricultural scientist should make full use of the natural resources available to him to help alleviate the problem of food supply-population imbalance. Most experts contend that an increase in animal production alone cannot solve the problem especially in the third world countries. Thus, plants need to be considered not only as carbohydrate source but for protein as well.

It has been known, however, that some plants contain naturally occurring toxicants which can be fatal to both man and animals. Indeed, scientists have tried to unravel the intricate mechanism involved in the

production of such toxins and their lethal effect in man and animals (Strong, 1973). One of the widely grown root crops with some toxic relatives is yam. During times of severe food shortage, the more popular toxic yam relative, *Dioscorea hispida* Dennst., locally known as *karot, nami* or *kot* is often resorted to as alternative food.

Nami, a wild yam species, grows abundantly in many parts of the Philippines and is widely used as an indigenous food although it is known to be toxic. The toxic substance which is in the tubers is an alkaloid called *dioscorine*. This can be removed by washing the tuber properly in running water. The plant is described as a vine, with trifoliate, hairy leaves and small pale yellow flowers borne on large compound inflorescence. The tuber is about two inches long and divided into three thin lobes which are more than twice as long as wide (Kay, 1973). Like most other root crops, it is rich in starch, minerals and vitamins. However, unlike most other root crops, yam has a much higher protein content compared to maize or rice (Coursey, 1982). This study was conducted to identify a detoxification method for wild yam using different periods of washing time. Furthermore, this study was aimed to assess the potential of the detoxified yam flour as binder in meat loaf formulation.

MATERIALS AND METHODS

Procurement of samples

Wild yam tubers were procured from a local market when the supply was high. The tubers obtained were about 10-12 mos old. These were processed immediately after procurement.

Detoxification of tubers

Fresh wild yam tubers were washed to remove soil particles and other extraneous materials, then peeled and sliced to about 3-4 mm thickness. Afterwards, these were mixed with different levels of salt concentration to hasten extraction of the juice. The levels of salt concentration ranged from 0.8-20% by weight of the sliced wild yam tubers. The salt-treated yam slices were placed in covered containers and allowed to stand overnight. The salted

slices were then transferred into nylon net bags; the juice pressed out by hand and washed under running faucet water at different periods, ranging from 1-24 h. The samples were dried in a forced-draft oven immediately after the predetermined washing period at a temperature of 50-55C. Representative samples from each treatment (*i.e.*, washing period) were chopped to form grits and used in the toxicity tests. The greater bulk of the chipped samples, however, were ground in a cereal mill and allowed to pass through a 60-mesh sieve. The resulting flour was then stored in an air-tight container and kept ready for use.

Toxicity

The acute type of toxicity test (Loomis, 1978), using chicks (Arbor Acre) as test fowl was employed in this study. The test required administration of the substance on one occasion. Observation of the test fowls ranged from a few hours to at least 24 h. However, survivors needed a follow-up observation period of 7 days more.

Dried yam grits from each treatment were fed to 18-day-old chicks for 24 h. Water and feed were given to the test fowls*ad libitum* during the 24-h test period. A total of 154 chicks were used, *i.e.* two per salt treatment per washing period. All chicks were placed in individual compartments in a chicken coop, assigned three-digit random code numbers and arranged in a randomized complete block design. Chick performance was closely monitored during the 6- to 168-h observation period. The rating scale used to gauge performance was: 4, normal; 3, weak; 2, very weak; 1, dead. A veterinarian performed necropsy on the dead chicks and on randomly chosen test chicks from those that survived. Determination of the best salt detoxification technique was based on the statistical analysis of the toxicity and necropsy test results.

Meat loaf

Meat loaf with a 70:30 lean meat-to-fat ratio was prepared. Corn starch was incorporated at the level of 3% of the meat total weight. Substitution of the corn starch with the detoxified wild yam flour ranged from 15-100%.

The meat loaf was baked at 350°C for 45 min in a 6.5 x 9.8 x 16.2 cm loaf pan. Approximately 1.5 cm cubical samples were given to 10 experienced panelists for sensory evaluation. Serving temperature was at about 65°C. Samples were coded with three-digit random numbers and the order of serving was randomized. Quality scoring was used in assessing the sensory attributes of crumbliness, juiciness, flavor and acceptability of meat loaf samples.

Determination of cooking losses as well as volume drippings of the product was done to evaluate the effect of wild yam flour as corn starch substitute in the meat loaf formulation. The volume of dripping from each treatment was determined by draining off the excess liquid from the loaf product and measuring its volume with a graduated cylinder.

Statistical analysis

Data obtained were subjected to analysis of variance (Snedecor and Cochran, 1967). The Duncan's Multiple Range Test (DMRT) was used to locate significantly different treatment means.

RESULTS AND DISCUSSION

Detoxification process

The salt-treated wild yam slices were allowed to soak in their salt solutions overnight. Observation showed that more juice was extracted from yam slices treated with higher salt levels. Moreover, their color was observed to be a lighter yellow than of those treated with lower salt concentrations. It is surmised that the difference in shade may be attributed to the difference in amounts of *dioscorine* present in the yam. Apparently, *dioscorine* which is described as greenish-yellow crystals (Merck, 1980), is easier to extract with the juice at higher salt concentration. On the other hand, the turgidity of the yam slices decreased with the increase in salt level. This is an indication that more juice was extracted at higher salt concentration.

Toxicity test

Evaluation on the performance of the test chicks revealed that those fed with the samples processed at lower salt concentrations and shorter

washing periods were generally weak during the first 24 h after feeding. They gradually recovered on the second day. Except for one test fowl, death occurred only among the chicks fed with undetoxified yam grits. Nothing wrong was observed from those fed with yam grits treated with higher salt levels and longer washing periods (Table 1). However, one test fowl fed with yam grits processed with 20% salt concentration and washed for 20 h died within six hours after feeding. This result was considered an isolated case. The death may have been due to factors other than the toxicant *dioscorine*. In fact, the chick was observed to be less agile than the other test fowls during the initial stage of the experiment.

Chicks fed with undetoxified yam grits showed a generally weakened appearance one hour after feeding. The chicks also manifested jerking movements while in recumbent position. Death resulted 6-24 h after the chicks were fed with the undetoxified (control) samples. Necropsy results showed that the internal organs appeared normal. Death was largely attributed to poisoning because of the symptoms exhibited by the control chicks prior to death. This confirmed the study of Bevan *et al.* (1956) which claimed that the toxic compound in yams is a convulsant poison. This poison is also reported to act as a depressant and decrease nervous activities (Loomis, 1978).

On the other hand, necropsy results of the surviving chicks that were fed with undetoxified yam grits revealed that their lungs were normally pinkish and had no observable lesions in the gizzard, proventriculus, heart, liver, kidneys and reproductive system.

Statistical analysis of the mean performance ratings of test fowls revealed highly significant differences among treatments. Interactions between salt treatment and length of washing; salt treatment and days after feeding; washing time and days after feeding were also highly significant (Table 1).

The results supported the findings of Kay (1973) that dioscorine could be removed by washing sliced tubers under running water. Likewise, it also confirmed Sulit's work (1967) which showed that detoxification of wild yam tubers can be efficiently carried out by brine treatment.

The toxicity test results were used to identify the best treatment combination of salt concentration and washing time needed to detoxify the

Table 1. Mean[1] performance rating[2] of test chicks fed with wild yam grits treated at different salt levels and washing time.

Salt Conc. %	Washing Time (hours)						
	1	2	3	6	12	20	24
00.0	2.2j	1.4l	2.2j	2.2j	2.8l	1.7k	3.7bc
00.8	3.1fgh	3.1fgh	3.2efg	3.2efg	3.7bc	3.7bc	3.7bc
01.6	3.0gh	2.9h	3.1fgh	3.2efg	3.7bc	3.7bc	3.9ab
02.4	3.2efg	3.0gh	3.2efg	3.2efg	3.7bc	3.8ab	3.8ab
04.0	3.1fgh	3.0gh	3.2efg	3.3def	3.7bc	3.7bc	3.8ab
06.0	3.1fgh	3.1fgh	3.4de	3.3def	3.8ab	3.7bc	3.8ab
08.0	3.3def	3.0gh	3.3def	3.7bc	3.7bc	3.8ab	3.9ab
10.0	3.7bc	3.4de	3.5cd	3.9ab	3.8ab	3.9ab	4.0a
12.0	3.8ab	3.7bc	3.7bc	3.9ab	3.9ab	3.9ab	4.0a
16.0	3.8ab	3.7bc	3.7bc	3.9ab	3.9ab	3.9ab	4.0a
20.0	3.9ab	3.8ab	3.8ab	3.9ab	3.9ab	2.41	4.0a

[1]N = 154. Values which common letter(s) do not significantly differ from each other.

[2]Range of ratings: 4, normal; 3, weak; 2, very weak; 1, dead.

tubers. Results indicated that samples treated with 12% salt (NaCl) solution followed by 1-h washing was not significantly different from samples treated with 1.6% salt and washed for 24 h. Based on these two extreme treatment combinations of salt and washing time, detoxification could be done with either low salt concentration and longer washing time or high salt concentration and shorter washing time. Nevertheless, it was only after 24 h of washing yam slices that the highest chick performance rating (perfect score of 4.0) was observed. This finding is important because it suggests that washing time could be cut short to one day as opposed to the report of Kay (1973) that detoxification of yam tubers by washing could be attained after 3-4 days. Longer washing period could cause tubers to ferment. Besides, starch could be washed away from the yam slices thus greatly affecting the functional properties of the yam flour.

The final detoxification process used was based on the salt level-washing time combination where the test fowls had perfect scores of 4.0 points. Minimum salt concentration with best chick performance was observed at 10% salt level with a 24-h washing time. Moreover, the results showed that all chicks fed with samples washed for 24 h without salt treatment behaved normally after 48 h, and had a perfect performance rating (4.0 points). Washing yam grits in less than 24 h resulted in death of some chicks. Wild yam flour was, therefore, prepared and processed using 10% salt concentration and 24-h washing. The resulting detoxified yam flour was used in the next loaf preparation.

Meat Loaf

Sensory evaluation of the meat loaf with the corn starch binder substituted at varying levels with the detoxified wild yam flour revealed significant differences among treatments for crumbliness and juiciness (Table 2).

Table 2. Mean[1] sensory scores[2] of meat loaf wild yam flour as binder.

Ratio of Corn Starch to Wild Yam Flour, %	Sensory Attributes			
	Crumbliness	Juiciness	Flavor	Acceptability
No binder	4.35bc	4.00d	5.10a	5.60a
100:0	4.35bc	5.30cd	5.45a	5.70a
85:15	4.45bc	5.45bc	5.80a	5.95a
65:35	4.15c	5.60abc	5.90a	6.25a
50:50	5.40a	5.75abc	5.80a	5.90a
35:36	4.75b	5.85abc	5.55a	5.70a
15:85	4.80b	5.80ab	5.80a	6.10a
0:100	4.60bc	3.15a	5.60a	5.55a

[1]N = 10. Values with common letter(s) within a sensory attribute are not significantly different from each other.

[2]Range of scores: Crumbliness: 8, extremely compact to 1, extremely crumbly. Juiciness: 8, extremely juicy to 1, extremely dry. Flavor: 8, extremely full rich blended flavor to 1, extremely weak and bland flavor. Acceptability: 8, extremely acceptable to 1, extremely unacceptable.

However, no significant difference was observed among treatments for flavor and acceptability.

For crumbliness, all other treatments varied significantly from 50% yam flour substituted product which had the highest rating. At this level of substitution the meat loaf product was not significantly different from the control and the product was considered least crumbly. All the other treatments showed slight crumbliness which could be attributed to the high water absorption capacity of the yam flour and its high starch content.

Juiciness, as a sensory attribute of meat loaf, was rated highest at 100% level of substitution. The higher the amount of yam flour substitution in the formulation, the higher the scores for juiciness. This indicates high water retention capacity of the product formulation. Water absorption of the dough mixture used as meat loaf binder is largely dependent upon the protein and starch components of the flour (Kent, 1966). This data supported the finding of FNRI (1980) that yam flour has higher protein and starch contents compared to other root crop flours.

As to flavor and acceptability, statistical analysis showed that treatments were not significantly different from one another. Although yam flour has a characteristic off-flavor, this was not perceptible in the product. Obviously, this was masked by the condiments used in the recipe for the meat loaf. This result showed that yam flour could still be used as meat loaf binder even at 100% level of substitution without the off-flavor being detected.

Data on percent cooking loss and volume of drippings from the meat loaf showed significant differences among the different treatments (Table 3). Cooking loss and volume of drippings were both inversely proportional to the level of yam flour substitution used. At higher levels of substitution, per cent cooking loss and volume drippings decreased. This clearly substantiates the findings on juiciness of the product. Juiciness increased as

Table 3. Cooking loss and volume drippings[1] of meat loaf using wild yam flour as binder.

Ratio of Corn Starch to Yam Flour, %	Cooking Loss %	Volume of Drippings ml
00:00	34.43a	87a
30:00	32.98b	69a
25:05	31.30bc	64a
20:10	30.48bc	53.5b
15:15	29.18bc	51.5bc
10:20	20.77c	47c
05:25	28.93c	44cd
00:30	28.20c	40de

N = 2. Values with common letter(s) are not significantly different from each other.

the level of substitution increased, which showed high water and oil absorption capacity of the yam flour.

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