THE USE OF SOLAR DRIED YAM IN COMMINUTED MEAT PRODUCTS

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ABSTRACT

A study was conducted to evaluate the feasibility of using Solar Dried Yam (SODY) for the replacement of some amount of meat in comminuted meat products. Yam used was *Dioscorea rotundata* and meat selected from the trimmings of the belly side, neck, shoulder and thigh of a bull and pork carcasses. Four (4) different emulsion-type sausages containing 5%, 10%, 15% and 20% Solar Dried Yam, in addition to control (no yam included) were used as treatments. Fats, carbohydrates, moisture and crude protein contents were measured. A 12-member taste panel sensorily assessed the product based on taste to determine of any difference between control and yam-containing product. The triangle test (BS 5929, 1984) was used. Protein content significantly decreased ($P<0.05$) as level of solar dried yam increases in the product. Including solar dried yam in comminuted meat products led to a high retention of moisture and consequently high cooking yield, as indicated by a relatively low cooking loss (8%) compare to that of the control sample (9%). Moisture content increased significantly ($P <0.05$) from about 17% in the control sample and 26-41% as the level of solar dried yam increased in the product. The panel were not able to detect any

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difference in taste in the product containing 5% solar dried yam, however, there was easy detection in differences in tastes of products containing 10-20% of yam. 420,000 cedis (US$185) was saved on the cost of producing 1 tonne of the product at 5% level of solar dried yam in comminuted meat product. It was therefore concluded that 5% level solar dried yam could conveniently be used in the replacement of fat in comminuted meat products with significantly no effect on taste of the product.

Keywords: Solar Dried, Yam, Comminuted meats, sausage, filler, extender

INTRODUCTION

Consumers perceive that processed meat especially those based on beef and pork are high in fat and cholesterol (Schutz *et al.*, 1988) and the meat industry has responded by producing lower fat products. Also, as a means of cutting down cost most manufactures usually incorporate non-meat additives in sausage formulation. These ingredients are usually added to improve water retention, fat binding, emulsifying and textural properties, increasing processing yield and reducing formulation cost (Inklaar and Fortunin, 1969, Smith *et. al.,* 1973). The manufacture of comminuted meat products is dependent upon the formation of a functional protein matrix within these products (Schmidt *et. al.,* 1981). However the increasing cost of animal proteins and the fact that the availability of meat is scarce in some countries (especially developing ones) have urged researchers to explore the possibilities of utilising different types of non-conventional filler sources in comminuted meat products in order to reduce formulation cost. Fillers from plant sources have the advantage of being produced in large quantities and at a lower cost.

Yam is a tropical crop plant, that produce edible tubers rich in carbohydrates with low protein content and is still the preferred staple food among most of the inhabitants of the forest zone and Southern part of the Savanna in West Africa (Ayensu and Coursey, 1972). In Ghana post-harvest losses of 50 - 60% have been reported for yams (Nurah, 1997).

Yam has a good binding, gel-forming and swelling properties and is highly soluble. It also contains some amount of sugars.

The objective of this study was to evaluate the possibility of using Solar Dried Yam (SODY) as filler in comminuted meat products. This will reduce the formulation cost of the meat products which will result in low price of the product and subsequently the affordability by the average person of such product. Solar drying method is used in drying the yam because it gives uniform drying, thereby preventing the growth of moulds. This would also be a solution, in part, to the high post-harvest losses being experienced.

MATERIALS AND METHODS

Preparation of Raw Materials

Tubers of Yam (*Dioscorea rotundata*) were peeled, washed and cut into slices and solar dried for (3) three days using a modified solar tunnel drier "Type Hohenheim" (Innotech Engineering Ltd., Leonberg, Germany). Internal temperature and relative humidity of the dryer was recorded to range between 30 $^{\circ}$C-57 $^{\circ}$C and 44.0%-55.7% respectively. The temperature of the environment was also between 21.5 $^{\circ}$C-29.7 $^{\circ}$C. The dried yam was ground and sieved through a plastic mesh of diameter of about 0.03mm to give a fine powdery texture. Lean beef was obtained from a bull of weight about 350kg and pork fat from a gilt of weight about 70kg. Meat was selected from the trimmings of the belly side, neck, shoulder and thigh of the beef carcass and neck side of the pork carcass.

Product Preparation

The following were the basic product formulation used in the experiment products.

Beef (lean)	50.0%
Pork fat	28.0%
Ice	15.5%
Water	3.5%
Salt	1.5%
Seasoning	1.2%
Phosphate	0.3%

The beef and pork fat were ground separately through a 3mm plate and 5mm plate respectively. They were kept in the cold room overnight before processing. A Super wolf MADO grinder, (MEW 513, Maschinenfabrik Domhan, GmbH, German) was used for grinding. MTK 561 MADO, Garant cutter was used for chopping in the following order; the ground beef and pork, seasoning (including phosphate), half ice and water, SODY, rest of ice and water; to a temperature of between 15-18 ˚C. Sample for chemical analysis were taken before stiffing into hog casings. A Patron MADO filler (MWF 591 MADO, German) was used in stuffing the product into hog casings and then linked.

The following levels of SODY inclusion was used in preparing the experimental products.

T0 - Control (0% SODY)

T1 - 5% SODY

T2 - 10% SODY

T3 - 15% SODY

T4 - 20% SODY

All treatments were taken into the smokehouse at the same time and hot smoked for about an hour. The temperature and relative humidity of the smokehouse was 90 ˚C and 28% respectively. Each treatment product was scalded separately to a core temperature of 65 ˚C. The products were cooled under tap water and packed separately in polythene bags for storage and further analysis.

Chemical Analysis

All treatments were analysed for fat, protein, fibre, ash and moisture. The Ether Extract fat determination method was used to determine the percentage fat of the product. The micro-Kjeldahl technique was used to estimate the total Nitrogen content and a conversion factor of 6.25 was used to calculate the crude protein content. The nitrogen free extract determination method of the proximate analysis was used in calculating the carbohydrate content based on dry matter basis.

Cooking Loss

Samples of each treatment were weighed before smoking and after cooking. The cooking loss was then estimated by subtracting the weight before smoking from the weight after cooking.

Determination of pH and water activity (Aw)

The pH of each product was measured using an electronic pH meter (HI 9024C, Hanna instruments) fitted with glass electrode (FC 200). A water activity meter (aw - wert - messer, Korrekturwerte nach Bundesanstalt fur fleischforschung, Kulmbach) was used according to the following procedure. The various products were sliced and filled to about two-thirds full and capped with the meter. It was then left for 3 hours after which the pointer readings as well as the corresponding temperature were taken.

Organoleptic Evaluation

A 12-member panel were given 0.5kg of a comminuted meat product containing the basic product formation for 4 weeks. The triangle test (BS 5929, 1984) was used. Some of the assessors were served with two of the test samples and one control, while the others were served one test sample and two control samples. They were asked to assess the product based on taste. Samples were prepared by warming products separately in the oven for 15 minutes. Pieces of treatment and control samples of about 4mm in length, wrapped in kitchen foil were distributed to the panellists according to triangle test combinations. After each round, panel members were made to rinse their mouth with water and bread. They were given sheets with tables and asked to identify the odd sample among the combinations served.

Statistical Analysis

The probability levels of the organoleptic evaluation was compared to a reference table for sensory differences (AMSA, 1978). One way Analysis of Variance (ANOVA) was conducted on the results of the various parameters measured to determine any significant different among the various treatments.

RESULTS, DISCUSSIONS AND CONCLUSION

OBSERVATIONS

During mixing the ingredients, it was observed that the consistency and texture quality increases as the level of SODY also increases. This probably was due to the good gel forming properties of yam. Amount of water added during processing also increased with increase in SODY level. This agrees with findings of Droughton *et al.* (1982) who evaluated the use of soy flour in meat products. Also the color of the product changed from reddish to brownish as t he level of SODY increased. This was reflected in the reduction in desire in terms of external appearance and colour. Ankrah (1975) observed a similar effect of "Konkonte" (the local cassava flour) due to a dark color imparted by the moulds and other micro-flora which makes the use of "Konkonte" as a filler in meat products undesirable.

Proper ties of Experimental Products

The protein content of the samples ranged between 44.5 and 25.4% (Table 1). The control had the highest protein due to the absence of SODY inclusion. Results from table 5 indicate a significant difference among the various levels of treatments. Protein content significantly decreased with an increase in the level of SODY inclusion. This decreasing trend is attributed to the fact that yam consist of a high amount of carbohydrates so as its level of inclusion is increased, it replaces an increasing amount of protein. This can affect the protein quality of the product. Annor-Frempong *et al.* (1995) studied the use of cassava and soyflour in comminuted meat products and found out that at level 5.4% protein content for soyflour and cassava flour were 14.7% and 11.2% respectively whiles at levels 9% and 10.8% of cassava flour inclusion the protein content was 10.9% and 10.8% respectively. It can then be said that the use of SODY has an advantage over cassava flour in terms of protein content which is an important parameter in a meat product.

Moisture Content and Cooking Yield of Products

Moisture content of the product significantly increased ($P<0.05$) with increasing levels of SODY (Table 1). This characteristic was also reported on a study using cassava flour (Annor-Frempong *et. al*., 1995) at levels 5.4%, 9% and 10.8%. Generally there was a constant rate of cook loss of about 8% for SODY containing products and 9% for the control. There were no significant differences among the treatments. This characteristic was not recorded in the products with the cassava flour.

Carbohydrates and Fat Content of the Product

The carbohydrate content was calculated based on dry matter basis. From table 1 carbohydrate content of products significantly increased ($P<0.05$) with increasing levels of SODY. This was very obvious because, yam contains high amount of carbohydrate and low protein content (about 3%). The fat content also significantly decreased ($P<0.05$) with increasing levels of SODY (Table 1). The decrease in fat content of the product is an advantage since such a product will have reduced occurrence of rancidity and thus long storage life.

Water Activity and pH

Water activity (Aw) is in the range of 0-1 which indicates the availability of moisture which is one of the most important requirements for microbial growth on meat and its products. Aw value of the various treatments increased with increasing levels of SODY and also moisture content increased at the same time. This is the usual trend since Aw is inversely proportions to the percentage moisture of the product. It has been established that the optimum aw for several food poisoning strains of *staphylococcus aureus* is about 0.99, below this the rate of growth is markedly diminished. Hence from Table 1 with the exception of 20% which had aw of 1.0 the rest can be stored at a temperature of - 1.5°C without any spoilage. The pH values ranged between 6.02 - 6.13. The control had the highest pH value due to the fat that processed meat and chilled red meat are less acidic. Since most bacteria grow optimally at about pH 7, the experimental products can be stored for a period of time without any adverse effect.

TABLE 1: Property of the Experimental product

PARAMETERS	TREATMENTS				
	Control (0%)	5%	10%	15%	20%
% Protein	44.5^a	40.8^b	30.4^c	26.4^d	25.4^e
% Fat	44.5^a	18.14^b	17.01^c	13.47^d	14.82^e
% Carbohydrate	6.39^a	38.36^b	47.38^c	48.94^d	50.58^e
% Moisture	17.9^a	26.2^b	32.3^c	38.6^d	40.8^e
% Cooking loss	9.0	8.0	8.4	8.3	8.0
Water activity	0.88	0.90	0.91	0.95	1.0
pH	6.13	6.05	6.02	6.06	6.04

$^{a-e}$ Means with same superscripts differ significantly different at $P < 0.05$

Sensory Evaluation

Table 2: Response of Panellists on Experimental Product

	TREATMENTS

	5%	10%	15%	20%
Number of panelist who were able to identify test samples	4	11	11	10
Number of panelist who were not able to identify the test sample	8	1	1	2

The organoleptic characteristics shown in the table 2 indicates that panellist were not able to detect any difference in taste in product with 5% SODY inclusion. The important sensory characteristics that contributed to this were texture, colour and taste, hence as much as 5% SODY could be added to meat products without affecting their acceptability. At levels 10-20% of SODY inclusion there was an easy detection of difference in taste due to poor color, texture and mealy taste.

Research works done on the use of coagulated lactalbumin curd in ground meat products indicates that 5-10% lactalbumin curd replacement might be used in pure ground beef without significantly changing its organoleptic quality. Annor-Frempong *et. al*., (1995) established that up to 9% raw cassava flour can be included in emulsion - type pork sausage without any significant change in organoleptic quality and hence acceptability.

Economic Aspect of Incorporating SODY in Comminuted Meat Products

It was calculated that for the production of one tonne (1 ton) of comminuted meat product containing solar dried yam, a gain of 418,500, 837,000, and 1,255,200 cedis would be made by using 5%, 10%, and 20% respectively of the filler to replace meat in the formulation. These gains are substantial and will lead to reduction of production cost.

CONCLUSION

SODY can be used as an additive in comminuted meat products up to 5% level of inclusion without any negative effect on colour and taste and the sensory characteristics of the finished product. However it cannot be used at higher levels even though there was a significant increase in processing yield because it affects the overall acceptability of the product negatively due to changes in color and taste. A substantial savings of 418,500 cedis (US$182) per 1 tonne of product containing 5% solar dried yam. Such a product will be cheaper as well as healthier.

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