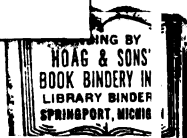
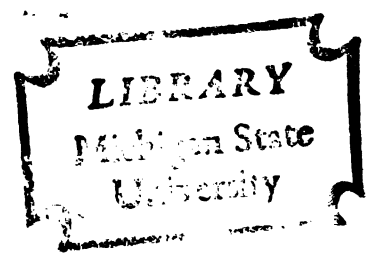


EFFECTS OF NIGERIAN PREPARATORY
PROCEDURES ON THE THIAMIN
RIBOFLAVIN AND ASCORBIC ACID
CONTENT OF FOODS

Thesis for the Degree of M. S.
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EFFECTS OF NIGERIAN PREPARATORY PROCEDURES
ON THE THIAMIN RIBOFLAVIN AND
ASCORBIC ACID CONTENT OF FOODS

By

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To My Father
Chief Josiah O. Adedipe

For the value he placed on Education.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
LITERATURE REVIEW	2
Studies Made in Nigeria	2
Studies Made in Other Parts of the World	5
MATERIALS AND METHODS	12
Preparation of Raw Samples for Vitamin Analysis	13
Storage of Samples	14
Washing Prior to Cooking	14
Method of Sauce Preparation	15
Stew Preparation	17
Sampling	18
Analytical Procedures	19
Food Analysis	20
Moisture and Nitrogen Determination . .	20
Conversion Factor for Calculation . . .	20
RESULTS	22
Preliminary Study	22
The Second Study	26
Vitamins Retained in Cooked Foods . . .	39
DISCUSSIONS	47
Calculation of the Contributions of the Foods to Nutrient Intake	50

	Page
SUMMARY	54
LITERATURE CITED	57
APPENDIX	64

LIST OF TABLES

TABLE	Page
1 Retention of Vitamins in the Three Sauces at the End of Preparation and After Storage at Room Temperature for Various Times	23
2 Recovery of Thiamin, Ascorbic Acid and Riboflavin During Preparation of Spinach for <u>Obe Efo</u> I	27
3 Retention of Vitamins in <u>Obe Efo</u> I During Cooking on Completion of Cooking and After Storage at Room Temperature	28
4 Retention of Vitamins in <u>Obe Efo</u> II During Cooking and on Completion of Preparation	36
5 Retention of Thiamin, Ascorbic Acid and Riboflavin in the Cooked Sauces	45
6 Vitamin Retention of <u>Obe Efo</u> II After Storage at Room Temperature	46
7 Preliminary Study Mgs of Vitamin in 100 gms of each of the Ingredients	64

TABLE		Page
8	<u>Qbe Efo</u> I: Mgs Vitamin Contained in the Raw Ingredients	65
9	<u>Qbe Efo</u> II: Mgs Vitamin Contained in the Raw Ingredients	66
10	Stew: Mgs Vitamin Contained in the Raw Ingredients	67
11	Second Study Mgs Vitamin in 100 gms of Each of the Ingredients	68
12	<u>Qbe Efo</u> I: Mgs Vitamin Contained in the Raw Ingredients	69
13	<u>Qbe Efo</u> II: Mgs Vitamin in the Raw Ingredients	70
14	Stew: Mgs Vitamin Contained in the Raw Ingredients	71
	Temperature Chart During Cooking	
15	<u>Qbe Efo</u> I	72
16	<u>Qbe Efo</u> II	73
17	Stew	74

LIST OF FIGURES

FIGURE		Page
1	Thiamine Retention Immediately After Cooking and During Storage of <u>Obe Efo</u> I, II, and the Stew at Room Temperature	25
2	Retention of Thiamin During Cooking of <u>Obe Efo</u> I	30
3	Retention of Ascorbic Acid During Cooking of <u>Obe Efo</u> I	32
4	Retention of Riboflavin During Cooking of <u>Obe Efo</u> I	34
5	Retention of Thiamin, Riboflavin, and Ascorbic Acid During Cooking of <u>Obe Efo</u> II	38
6	Ascorbic Acid and Riboflavin Retention Immediately After Cooking and During Storage of <u>Obe Efo</u> I at Room Temperature	42
7	Ascorbic Acid and Riboflavin Retention Immediately After Cooking and During Storage of <u>Obe Efo</u> II at Room Temperature . . .	44

INTRODUCTION

The importance of any food as a source of nutrients depends on the amount of the nutrients present at the time of consumption. Riboflavin was found to be deficient in Nigeria, which was accompanied by a low intake of thiamin and ascorbic acid in prepared foods; even though plasma levels of the latter vitamin were very high.

This study is devoted to determining the alteration in thiamin, riboflavin and ascorbic acid content encountered when vegetables and meats are made into soups and sauces according to Nigerian methods of household cooking and what contributions the foods make to the nutrient intake of the Nigerian people.

LITERATURE REVIEW

In recent years, much attention has been paid by different groups of scientists to the nutrient contents of African foods. This is a very important aspect of African nutrition because a great deal has been published about the malnutrition in Africa, evident from the various nutritional diseases found during investigations by different workers. However, little is known about the nutrient contents of African foods and the alterations which might occur due to the native methods of preparation and storage of foods. Knowledge of this sort is necessary, to determine whether the malnourished conditions found are due to a lack of essential nutrients in the foods consumed or to a destruction or loss of the nutrients during preparation or supply to an inadequate intake of those foods which furnish the essential nutrients.

There is evidence that each of the three suppositions may be true to some degree and the summation of all three factors may precipitate the final disease syndrome. For instance, Dema (1965) observed that the ignorance of food values and the nutritional needs of the different members of the family lead to inequitable distribution of protein-rich foods such as meat and fish. The dietary measurements made at Ijana-Itarua (Ilesha, Nigeria) in February-March 1962 confirmed the popular view that the adult males eat the richest portions, leaving the growing children with relatively little.

The study mentioned above was made in Nigeria where it was later observed that apart from imbalance of protein and calories in diets, frank malnutrition is not observed in adults but in children (1965, Nigerian Nut. Survey). The same source noted that riboflavin-rich foods are limited in supply.

There is, however, little information on the nutrient content of the finished products after cooking and on how much is lost during preparation. In the recent nutrition survey carried out in Nigeria during February to April, 1965, a comprehensive study was made to identify nutritional deficiencies. The survey included dietary, biochemical and a clinical evaluation of large segments of the population. This was supplemented with a survey of agricultural practices, food use and nutrient intake, as well as studies of the possible relation of nutrition to mental development, and to the eye lesions found in the country.

The population studied included civilians, school children, women in prenatal clinics, children at welfare clinics, the military, and the police. The dietary survey included the school lunch programme at Lagos.

In the dietary survey at the military school in Zaria, observations showed that the most popular ways of preparing foods in Nigeria involve either boiling or frying. For the cadets, meat or fish was stewed or fried, or made into a soup or sauce containing other ingredients like fresh or dried chillies.

The following method was employed at the military school for preparing the meat soup: The meat used was a less tender cut, so it was boiled in water until tender (approximately 2-3 hours). The other ingredients were added to the meat and broth near the end of this time. These included ground onions, chillies, fresh tomatoes, melon, seed meal, palm oil and water. Green vegetables were added to the fish or meat soup during the later part of cooking. They were cooked for one hour or more.

In the civilian dietary study, it was observed that food prepared but not consumed at a given meal was usually eaten at subsequent meals, especially in the case of stews and vegetable sauces. These two dishes were often prepared in such quantities as to feed the family for one, two or sometimes three days.

Dietary information concerning the civilians indicated that they received adequate amounts of iron, phosphorous, vitamin A, niacin and ascorbic acid at the time of the survey. However, protein, calcium and thiamin intakes were low in several locations and riboflavin intake was low in most of the locations.

In general, among all the groups studied, riboflavin deficiency as evidenced by low dietary intakes and urinary excretion levels was acute, while thiamin intake was low or borderline in several cases; ascorbic acid intake was low in a number of areas, though serum levels were uniformly high.

Prior to this study, Nicol (1954-1957) and associates did a comprehensive survey of the types of foods consumed with special attention to the caloric and protein intakes of

people in five vegetation zones. They observed (1956) that 80% of ascorbic acid is destroyed when foods such as yams and other root vegetables are soaked, pounded and boiled into "foofoo". The preparation of flour from cassava destroys 100%, while vegetable leaves and such fruits like peppers, when boiled in an emulsion of oil and water loses on an average, 67% of the ascorbic acid present in the edible portion.

In another study on nutrient intakes of urban dwellers in Lagos, Nigeria, J. Mc'fie (1967) referred to low intakes of the B vitamins, notably riboflavin which resulted in the appearance of angular stomatitis in a number of children.

O. L. Oke (1966) of Ibadan is chemically analyzing many Nigerian foodstuffs. He observed appreciable amounts of ascorbic acid is lost during processing of tubers and starchy roots, but a negligible amount is lost when they are cooked. He also observed that kolanuts appear to have as much ascorbic acid as spinach and citrus fruits.

In another study (1966) he observed that when liver, spleen, kidney, lungs and heart of beef cattle were boiled for ten minutes, losses of the ascorbic acid due to cooking were highest in the spleen, resulting in an average destruction of 69%. Other organs lost approximately 52%.

He (1967) also reported that most of the Nigerian vegetables in the raw state are rich sources of ascorbic acid with values ranging from 18 mgs/100 gms to 95 mgs/100 gms of ascorbic acid on fresh weight basis. An appreciable amount is lost on boiling with losses ranging from 22% to 78%.

Turning to investigations in other parts of the world, one finds that there is an enormous literature on the changes

in nutrient content of foods, caused by industrial and household handling and storage. Numerous studies on the vitamin losses caused by washing, chopping into small pieces, frying, boiling, holding at high temperatures or storing have been done.

O. Mickelsen, et al. (1934) found that stability of vitamin B, in meats during cooking depended upon the method of cooking. Frying produced the least change in B content as shown by the almost complete preservation of vitamin in fried beef round and fried ham. A 35% loss was recorded for pork loin and 45% in veal chops.

Roasting has a greater destructive action on the vitamin B in the three samples. Fifty to 60% losses were recorded. Broiled beef kidney showed a stability of the vitamin similar to that of the broiled meat when cooked for 1 hr. 45 minutes. The marked destruction of the vitamin produced by the above preparatory procedures may be associated with the long time and high temperature used in cooking.

E. Anghey, et al. (1940) showed that cooking destroyed less of the B vitamin than was formerly supposed. They found no loss of thiamin in 300 gms of carrots boiled for 23 minutes in 100 mls of water, and also by the pressure cooker method. Boiling whole potatoes in salt water for 36 minutes resulted in 33% loss of thiamin. This loss was accounted for by 20% destruction and 13% leached into the cooking liquid. When 55 gms of spinach was cooked for nine minutes, 30% loss of thiamin was obtained out of which 8% of the loss was recovered in the cooking liquid.

Roscoe (1930) discovered that spinach boiled for 15 minutes lost half its vitamin B₁ content in the cooking liquid, while Hoff (1933) reported more than 50% loss of vitamin B₁ in spinach cooked by ordinary household methods. Thus excessive vitamin B₁ losses reported by some investigators might have been due to cooking with too large quantities of water or cooking for long periods of time.

Latze and Hopper (1936) reported a 12% destruction of Vitamin B₁ in pork which had been ground and subsequently stirred and cooked in a double boiler until it reached a constant temperature of 90°C.

J. M. McIntire, et al. (1943) studied retention of thiamin, riboflavin and nicotinic acid in samples of pork cooked by braising for 45 minutes at an internal temperature of 87 degrees and roasting for 3-3 1/2 hours, they found that the average retention of vitamin in the meat was 70% for thiamin, after roasting and boiling, and 50% after braising. For riboflavin, 85% was retained by all methods of preparation. Appreciable amounts of each of the vitamins were found in the drippings, particularly from braised loin cuts.

C. H. Johnston, et al. (1943) recorded 30% retention for thiamin in fresh peas, which were overcooked, with the loss in the cooking water about 45%. Regardless of method of cooking, 64-70% of the riboflavin remained in the peas after cooking.

Effect of the amount of cooking water on vegetables was studied by Martha Porgieter, et al. (1950). They found that with increase in the volume of cooking water more

ascorbic acid was lost from boiled kale. In that study, 25 gms, 312 gms and 600 gms quantities of water were used. Losses varied from 22.2% for the smallest volume of water to 58.5% for the largest volume. Increasing the cooking time resulted in increased loss of ascorbic acid with all three cooking methods. In the drained, boiled kale, there was a direct linear relationship between the log of the cooking time and the amount of the vitamin lost when three cooking times, 6, 9, and 13.5 minutes were compared.

Variations in cooking time, however, had much less effect than variations in volume of cooking water. Inclusion of the ascorbic acid in the cooking water resulted in no significant differences due to variations in cooking times. Therefore, the increased losses with increased cooking time were due to extraction of more of the vitamin from the kale. Kale, cooked in the medium amount of water for a medium length of time lost 28% thiamin as compared with 49% for that cooked in the large amount of water for the same length of time. Practically all the thiamin lost was recovered in the cooking water. Kale boiled for the short and medium times showed no significant difference in thiamin content either in the drained kale or in the kale plus cooking water. No additional loss was obtained for the long cooking time.

B. Barnes, et al. (1943) also studied effects of varying amounts of water used in cooking broccoli. Quantities of water used were 100, 500 and 1000 gms. With 100 gms of cooking water, 10% ascorbic acid was leached into water while 8.0% unaccounted for loss occurred. In 500 gms of water, only 57% of ascorbic acid remained in the broccoli,

32% went into solution and 11% was lost. One thousand grams of water gave only slightly greater loss into solution than 500 gms of water. Fifty-three per cent ascorbic acid remained in the vegetable and 37% went into solution.

McIntosh, Tressler and Fenton (1942) found the same trend of vitamin loss with increase in amount of cooking water. From 1/4 to 1/2 of the ascorbic acid may be leached from the vegetables when boiled in increasing amounts of water. Broccoli was cooked for three different time intervals resulting in undercooking in two minutes, just done in five minutes and overcooking in 11 minutes. Percentage retention of vitamin C was approximately the same for done and overcooked, values were 57% and 55% respectively. Percentage in solution was also about the same, 32% and 33%. The undercooked vegetable retained 64% of its vitamin but the taste panel did not like it.

G. H. Bendix, et al. (1951) studied the effect of time, temperature, and other variables on thiamin stability in peas, corn, lima beans and tomato juice. At elevated temperature and their normal pH when the log of percentage retention was plotted against time, a negative linear relationship was shown for thiamin in peas, while in each of the three other products the curves are characterized by a large initial slope which leveled off with time.

More recently, Isabel Noble (1967) cooked six types of vegetables till just tender, 5, 10, and 50 minutes overcooked beyond the tender stage. She used both ordinary boiling and pressure cooker methods. Average retention in the tissues cooked for the longest and shortest periods in boiling water

and the pressure cooker were respectively 35% to 44% and 66% to 78% of the original ascorbic acid. The unaccounted portion amounted to about 15% for each cooking period.

J. C. Somogy (1964) made an extensive review of literature on effects of processing and storage on the composition of foods. Therein, he reported that according to Doesburg (1957), the retention of vitamin C in different vegetables, especially spinach, stored at 20°C for 60 hours showed a negative slope. When percentage retention was plotted against time in hours, fresh spinach lost 48% and 75% of its ascorbic acid content respectively in the first and second day of storage at 20°C. The slope for the losses of ascorbic acid in sliced endives and sliced beans were not as steep as that of spinach; sliced cabbage showed a slight initial rise in the first twenty hours only to drop gradually to about 88% retention by the end of 60 hours. This gave rise to a curve with a concave shape.

Van Duyne, et al. (1954) showed that when 400 gms of cabbage was boiled in 800 mls of water for seven minutes, held in the refrigerator for 24 and 72 hours and reheated, there were significant losses of ascorbic acid. Cabbage tested immediately after cooking retained 57±2% of its ascorbic acid. Retention after 24 hours storage in the refrigerator and reheating was 29±3%. Storage for 72 hours and reheating gave 24±% retention. The difference between the ascorbic acid contents of the two reheated cabbage samples is not significant.

More recently, Alfred Lopez (1967) studied the influence of time and temperature on ascorbic acid stability during storage in different types of orange juice including synthetic orange juice to which ascorbic acid was added. The ascorbic acid showed a remarkable stability; even at room temperature there was no appreciable loss. Thus he recorded about 1-2% difference in ascorbic acid content of fresh orange juice stored for 24 hours and 48 hours at room temperature compared with ascorbic acid values prior to storage.

MATERIAL AND METHODS

Food items were purchased at retail in two lots. Items which were already processed like dried red pepper, dried shrimps, peanut oil, were bought a few days before the actual sauce preparation and were stored in the refrigerator at 2°C.

Perishable items like beef and spinach, fresh tomatoes and onions were purchased early in the morning on the day of sauce preparation. Tomatoes were immediately pitted, weighed and homogenized in the one gallon Waring blender for three minutes. The homogenate was thoroughly mixed together and samples were put into weighed one cup freezer jars. Grinding or blending samples are acceptable methods for preparing materials for vitamin analysis. Onions were treated similarly except that after removal of the non-edible portion they were homogenized with one quarter their weight of distilled water.

The contents of all the fifteen packages of spinach were weighed together on the Toledo balance which was accurate to one gram. After the non-edible portion was removed, the spinach was placed in a big container and mixed. Samples for the determination of vitamin in the raw state were taken from different parts of the whole batch. The rest of the sample was divided into two portions for the first and second vegetable sauces.

The meat was a beef chuck roast weighing seven pounds. The meat was cut into stew size pieces after some of the

fat had been trimmed off and was again reweighed. By random hand picking, the meat was divided into three equal portions. One third was immediately weighed and placed in plastic bags and frozen at -22°C . From one of the two portions remaining, some pieces were added to the other so that the pieces in the stew were more than in the second vegetable sauce. The meat in each portion was weighed and placed in covered plastic bowls and kept in the cold room until needed.

The three bags of dried shrimps were pooled and ground with the meat grinder. The ground shrimp was mixed and the amounts needed for each vegetable sauce were weighed out.

Six tins of dried powdered red pepper were mixed by rolling the powder up and down on a brown paper with the aid of a spatula. The pepper was stored in the refrigerator in quart jars at 2°C .

Preparation of Raw Samples for Vitamin Analysis

After the initial preparation of each ingredient as described previously, the spinach, tomatoes, onions and beef were prepared for ascorbic acid analysis by homogenizing them in the Waring blender with 6% trichloroacetic acid (TCA) in a one to one ratio.

Dried red pepper was first hydrated by blending it with water using 25 gms of pepper to 50 gms of water. The whole homogenate was again blended for two minutes with 75 gms of 6% TCA.

Fifty gms of dried ground shrimp were blended with 150 gms of water and the entire shrimp was again homogenized with 200 gms of 6% TCA.

For riboflavin and thiamin, spinach was homogenized with water in a one to one ratio in the Waring blender, while the meat was put through the meat grinder three times. Homogenates of tomatoes and onions prepared as described previously, and powdered dried pepper and ground dried shrimp were used for the analysis of these two vitamins.

Storage of Samples

Because it was not possible to do the analysis immediately after preparation, the samples were stored at -22°C until analysed. Storage at this temperature results in no appreciable loss of vitamins even as long as seven months of storage. Storage involved wrapping the bottles with brown paper to protect the samples from light or any ultra-violet light source which might destroy light sensitive materials like riboflavin. During preparation of samples for analysis the light intensity in the room was reduced to a minimum and care was taken to keep the samples away from direct light of any kind.

Washing Prior to Cooking

Operations like washing of meats and leafy vegetables in the raw state prior to cooking do not result in a significant loss of vitamins. Because of this, samples were not saved for analysis after these operations.

Van Duyne (1944) soaked shredded cabbage in water for one and three hours and left it in air for one hour. He recorded 94 ± 2 , 96 ± 2 and 97 ± 2 ascorbic acid retention respectively.

Holmquist, et al. (1954) found that with peas, washing prior to blanching did not result in significant losses of ascorbic acid, thiamin, riboflavin and niacin.

Method of Sauce Preparation

The three sauces consisting of a stew and two types of vegetable sauces were prepared according to methods acceptable to Nigerians. The methods of sauce preparation for the military (1965) in the Nigerian nutrition survey at Zaria mess were noted. Two other Nigerian cook books were consulted, as well as three Nigerian women in residence at Michigan State University at the time of the study.

The ingredients used in Obe Efo I consisted of: a leafy vegetable-spinach, fresh tomatoes, fresh onions, dried shrimps, peanut oil, dried red pepper, monosodium glutamate as seasoning and salt to taste.

Obe Efo II used essentially the same ingredients, except that it had some meat added to it, while the stew contained the same ingredients including meat but excluding spinach and shrimps.

Method of Sauce Preparation

Obe Efo I: By weighing the sauce pan before and after water was placed into it, the initial weight of water was obtained as 1500 gms. When the water started to boil, its weight was 1450 gms. Previously trimmed fresh spinach was placed in the boiling water for four minutes. Since the quantity of spinach was so large, boiling was done in two lots.

An average Nigerian woman is not particular about the amount of water used. (O. L. Oke, 1967). She boils the

spinach in a slight excess of water which is later discarded.

At the end of ten minutes, the spinach was removed into a container holding 1000 gms of cold tap water in which the first rinsing was done for two minutes. Second rinsing was carried out in another container of 1000 gms of cold tap water. R. O. Williams (1957) suggested preparing greens by boiling in water until soft, removing them from the boiling water into a collander or basket and running cold water over them, or washing in a basin of cold water. The spinach was removed from the second rinsing water and excess water was removed by squeezing the spinach into balls.

The sauce base was prepared by heating the homogenized onion, tomato, pepper and oil for 25 minutes before the cut-up spinach was added. An additional cooking period of 18 minutes followed during which shrimp and salt were added to taste thereof recorded.

Obe Efo II: (Spinach was not preboiled) One thousand three hundred sixty four grams of cut-up and washed pieces of beef meat were placed in a saucepan along with 649 gms of water and salt and boiled for 25 minutes.

After this time, previously homogenized tomato, pepper and onions were added. The weight of the pot both before and after addition of each ingredient was recorded so that it was possible to calculate how much of the ingredient was used.

Boiling continued for another 55 minutes at which time 1797 gms of trimmed, washed, raw cut-up spinach was added. The spinach was mixed with the sauce and left to cook for 11 minutes. A sample was taken at this time. Shrimp, oil, mono-sodium glutamate and salt were added 16 minutes later and the

sauce was left to cook for 20 minutes more. Total cooking period for each item is recorded in table 16.

Stew Preparation (Alapa)

One thousand two hundred forty seven grams of washed and cut-up chuck beef, 115 gms of water and salt were boiled for one hour with occasional stirring with a large spoon to ensure uniform cooking.

In another sauce pan, the oil was warmed for a few minutes and onions, tomatoes, and pepper were added. After cooking for 25 minutes the stock from the boiled meat was also added along with the previously boiled meat. A little water was used to rinse the sauce pan in which the meat was boiled and this was also added to the sauce. The stew was allowed to cook for 17 minutes more during which time more salt was added to taste.

In a preliminary study the only samples of sauces taken were immediately after preparation and six, 19, and 26 hours of storage at room temperature, 83⁰F.

However, in a second study as shown above, emphasis was laid on stages prior to the end of preparation. Thus, for Obe Efo I, samples of water used for boiling and rinsing of the spinach were saved for analysis of vitamins. Also, sample of the sauce was taken when shrimps were added before the end of preparation, in addition to samples taken as soon as the preparation ended and after 13 1/2 hours of storage at room temperature.

For Obe Efo II, samples were taken 11 minutes after the spinach was added and another sample as soon as the shrimp was added. The usual sample, at the end of preparation, and after

17 and 22 hours of storage at room temperature were taken.

For the stew, only the samples immediately after preparation, 13 2/3 and 21 hours of storage at room temperature were taken.

For all the sauces the temperature of the stove was turned to high at the beginning and then down to medium when the sauce began to boil. Occasional stirring was done to ensure uniform cooking. The temperature of the sauces were taken from time to time to determine the average internal temperature of the sauce during cooking.

Sampling

In the case of Qbe Efo I, samples were taken immediately after stirring and these were homogenized. Qbe Efo II was stirred and two pieces of meat, along with two spoonfuls of the sauce, were taken as a sample. Four of such samples were put into preweighed Waring blender and reweighed so that the weight of the sample was obtained prior to blending. Samples were thus homogenized and then placed into three weighed one cup freezer jars. The stew was sampled in a similar manner. It was not necessary to dilute samples with water because they were all soft enough and maintained a good consistency. Homogenates were placed in two or three previously weighed screw capped jars and were then reweighed. The bottles were then ready for storage in the freezer at -22°C .

Preparation of samples for ascorbic acid analysis was as for the raw samples.

Prior to analysis the samples were placed in the refrigerator at 4°C to thaw overnight. Some samples, such as

tomatoes and onions which contained a lot of water and were frozen into blocks of ice, needed to stand for one or two hours at room temperature on the following day in order to obtain representative aliquots of samples.

Analytical Procedures

Thiamin: The thiochrome method as outlined by Mickelsen and Yamamoto (1958) was used to analyse the food samples without any further modifications. The thiochrome method depends on the in vitro oxidation of thiamin to thiochrome, which fluoresces in ultraviolet light in the absence of other fluorescing substances.

Riboflavin: The fluorometric method as proposed by the riboflavin Assay Committee (Andrew J. S., 1943) was applied to food samples. The method is based largely on those of Conner and Straub (1941) which used absorption of extract on Florisil as a purification technique to remove interfering pigments formed in heated food samples and the compensatory method of Hodson and Norris (1939) which involves measurement of extracts before and after addition of a known amount of riboflavin.

The riboflavin was measured as the difference between the fluorescence before and after reduction of the Florisil eluate with sodium hydrosulfite.

Ascorbic acid: Was determined by a method based on that of Row and Osterling (1948). This method depends on the oxidation of the ascorbic acid to dehydroascorbic acid and then to diketogulonic acid which is later coupled with 2, 4 -dinitrophenylhydrazine to yield an orange insoluble

osazone. The osazone is dissolved in conc- H_2SO_4 giving an intense red solution, the absorbance of which is determined spectrophotometrically.

Food Analysis

Each foodstuff that went into the sauce preparation was analysed separately and the values obtained were used in the calculation of the sauce composite. These values are shown in tables 7-14.

There are considerable differences between the analysed and calculated figures of the constituents of individual diets as shown by Toscani (1948). Leverton (1960) also showed that calculated food values only present an average around which the analysed figures may fall. Since many factors are taken into consideration in deriving the figures in the food tables, they provide somewhat different information about the product consumed.

Moisture Determination

The amount of moisture in every sample was determined by drying at 70°C under vacuum for 48 hours in covered aluminium pans.

Nitrogen Determination

The sauces stored at room temperature for 13, 16 and 21 hours were analysed for Nitrogen by the Micro Kjeldah technique.

Conversion Factor for Calculation

To get the amount of vitamins in 100 gms of the raw

materials as well as in the original ingredients, aliquots for various analysis were corrected for the water added during the preparation of the homogenates by multiplying the amount obtained from vitamin analysis by the appropriate dilution factor. Where the water used for blending was four parts of ingredients to one part of water, then the conversion factor would be 1.25.

However, all the vitamin values for foodstuffs, both in the raw and cooked samples were expressed on the dry weight basis so as to have a common grounds for comparison.

RESULTS

Preliminary Study

Thiamin: Obe Efo I, at the end of preparation retained only 40% of its initial thiamin. Storage for six and 19 hours at room temperature (83°F) resulted in further losses to values of 31 and 30% respectively. Obe Efo II, when prepared, had 50% of its initial thiamin. Storage at room temperature for six, 21 and 26 hours resulted in an apparent rise in thiamin content to 56, 59 and 58% respectively. The Stew (Alapa) retained 99.8% at the end of its preparation while 73, 63 and 60% retention were recorded for the three storage times at room temperature (Table 1 and Figure 1).

Ascorbic Acid: Not all samples were analysed. For instance, complete destruction of ascorbic acid occurred in Obe Efo I at the end of its preparation. Analysis of the sample stored for six hours gave no spectrophotometric readings, and so, the sample stored for 19 hours was not analysed.

At the end of its preparation, Obe Efo II retained 13%, while storage of this sauce at room temperature for six, 19, and 26 hours gave 6%, 5 and 6% retention respectively. At the end of cooking, the stew (Alapa) retained 7% of its ascorbic acid.

In this study the volumes of water used in boiling and washing the spinach in Obe Efo I were not measured. It was evident that interfering substances disturbed the ascorbic acid analysis, therefore, in the second study, acid washed Norit was used instead of bromine for oxidation and

Preliminary Study

Table 1. Retention of Vitamins in the Three Sauces at End of Preparation and After Storage at Room Temperature for Various Times. All Values are Expressed on Dry Weight Basis

Sauces	Thiamin Retention									
	Prepa- ration	Finished	Hours After Preparation						Mgs/ 100gms	% Re- tention
			6		19		21			
Mgs/ 100gms	% Re- tention	Mgs/ 100gms	% Re- tention	Mgs/ 100gms	% Re- tention	Mgs/ 100gms	% Re- tention	Mgs/ 100gms	% Re- tention	
Obē Efo I										
a) Initial raw	0.63									
b) Final cooked	0.25	39.68	0.192	30.90	0.190	30.16	-	-	-	-
Obē Efo II										
a) Initial raw	0.28									
b) Final cooked	0.14	50.35	0.156	55.64	-	-	.166	59.23	0.162	57.85
Stew										
a) Initial raw	0.106									
b) Final cooked	0.1058	99.8	0.078	73.13	-	-	0.067	63.20	0.063	59.53

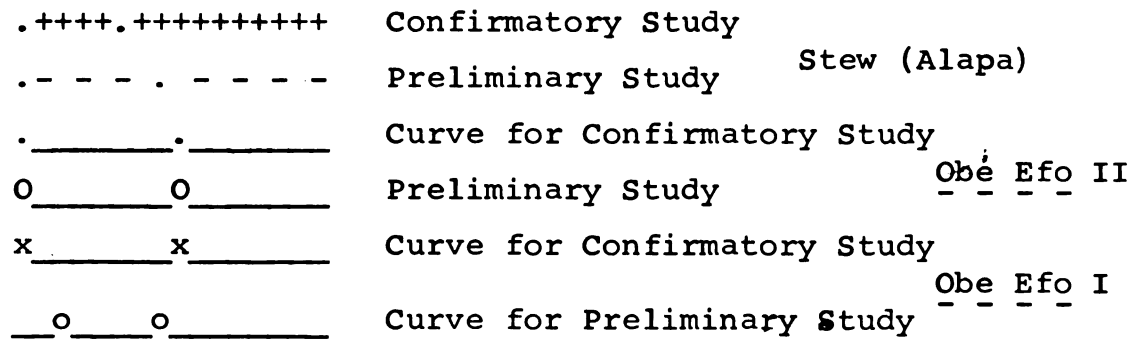
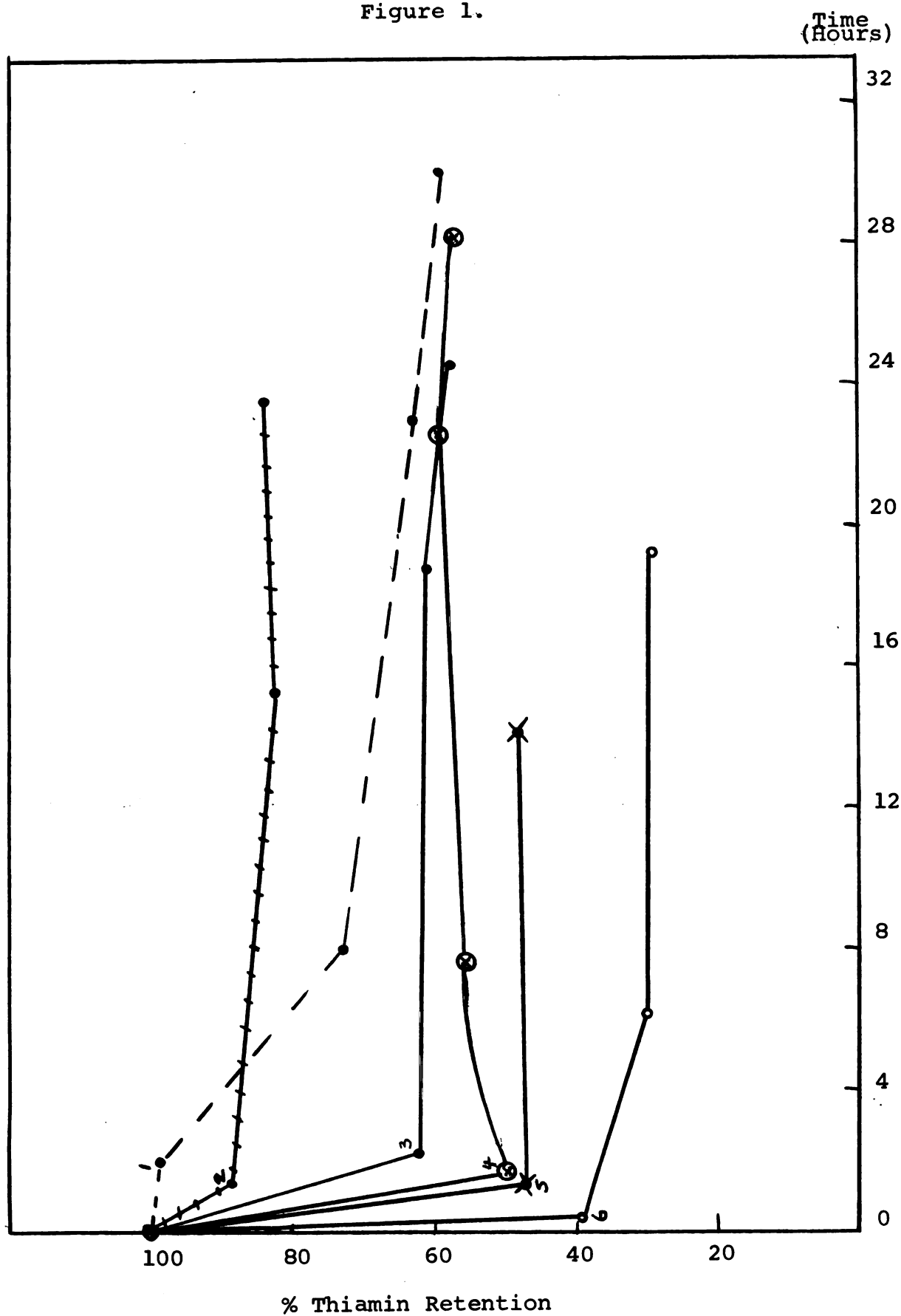


Figure 1. Thiamin retention immediately after cooking and during storage of Obe Efo I, Obe Efo II, and stew (alapa) at room temperature. 1, 2, 3, 4, 5, and 6 represent thiamin retention of the sauces at the end of cooking.

Figure 1.



trichloroacetic acid instead of metaphosphoric acid in precipitating proteins.

Since the preliminary study showed that the most precipitous loss of ascorbic acid occurred during preparation of all three sauces, and also the same thing obtains for thiamin in Obe Efo I and II, further studies were concentrated on the losses of these vitamins associated with the various stages of preparation.

On the other hand, since the stew retained most of the thiamin during preparation and it is seen from the raw composite, not to contribute much ascorbic acid, intermediate stage sampling was not necessary.

The Second Study

Obe Efo I: The spinach used for this sauce was boiled and rinsed twice in cold water. After the second rinsing, the retention of thiamin, ascorbic acid and riboflavin in the boiled spinach was 29, 41, and 43% respectively. There was 38, 11 and 32% of thiamin ascorbic acid and riboflavin in the water used for boiling the spinach, 8, 3, and 11% of the three vitamins in the first rinse water and 8, 7, and 7% in the second rinse water respectively. Total recovery for thiamin, ascorbic acid and riboflavin from the preceding were 83%, 62, and 93% respectively (Table 2).

Immediately after the dried shrimps were added to Obe Efo I, a sample was taken. At that stage, the sauce contained 50, 45, and 52% of the thiamin, ascorbic acid, and riboflavin in the original ingredients (Table 3).

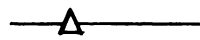
Sample	Thiamin			Ascorbic Acid			Riboflavin			
	Weight in Gms	Mgs/ 100gms	Total mgs	% Reco- vered	Mgs/ 100gms	Total mgs	% Reco- vered	Mgs/ 100gms	Total mgs	% Re- vered
Spinach Raw	1576	0.138	2.17		44.02	693.76		0.207	3.26	
Water for Boiling	1450	0.057	0.83	38.2	5.14	74.53	10.74	0.072	1.04	31.90
Water for first Rinsing	1000	0.018	0.18	8.2	1.85	18.50	2.61	0.037	0.37	11.35
Water for second Rinsing	1000	0.017	0.17	7.8	4.58	45.80	6.60	0.023	0.23	7.06
Spinach Boiled Washed & Squeezed	866	0.073	0.64	29.3	16.43	284.57	41.02	0.159	1.38	42.33
Vitamin Recovered			1.82	83.87		423.40	61.03		3.02	92.64

Table 3. Retention of Vitamins in Obe Efo I During Cooking, On Completion of Preparation and After Storage at Room Temperature

Sauce Sample		Vitamin Retention					
	Thiamin		Ascorbic Acid		Riboflavin		% H ₂ O
	Mgs/100gms dry weight	% Re-tained	Mgs/100gms dry weight	% Re-tained	Mgs/100gms dry weight	% Re-tained	
Composite	(1) 0.84	(2) 0.517	(1) 344.26	(2) 240.55	(1) 1.22	(2) 0.70	
	(1) 0.42	(1) 50.0 (2) 81.2	(1) 155.18	(1) 45.08 (2) 64.51	(1) 0.64	(1) 52.46 (2) 91.43	84.45
End of Preparation	(1) 0.40	(1) 47.62 (2) 77.30	(1) 86.19	(1) 25.03 (2) 35.83	(1) 0.48	(1) 39.88 (2) 68.86	83.30
After 13 3/4 hours	(1) 0.405	(1) 48.19 (2) 78.30	(1) 89.49	(1) 25.99 (2) 37.20	(1) 0.45	(1) 36.72 (2) 64.00	81.66

Note: (1) Refers to values based on amount of vitamins in the raw spinach.

(2) Refers to values based on amount of vitamin in the preboiled spinach.



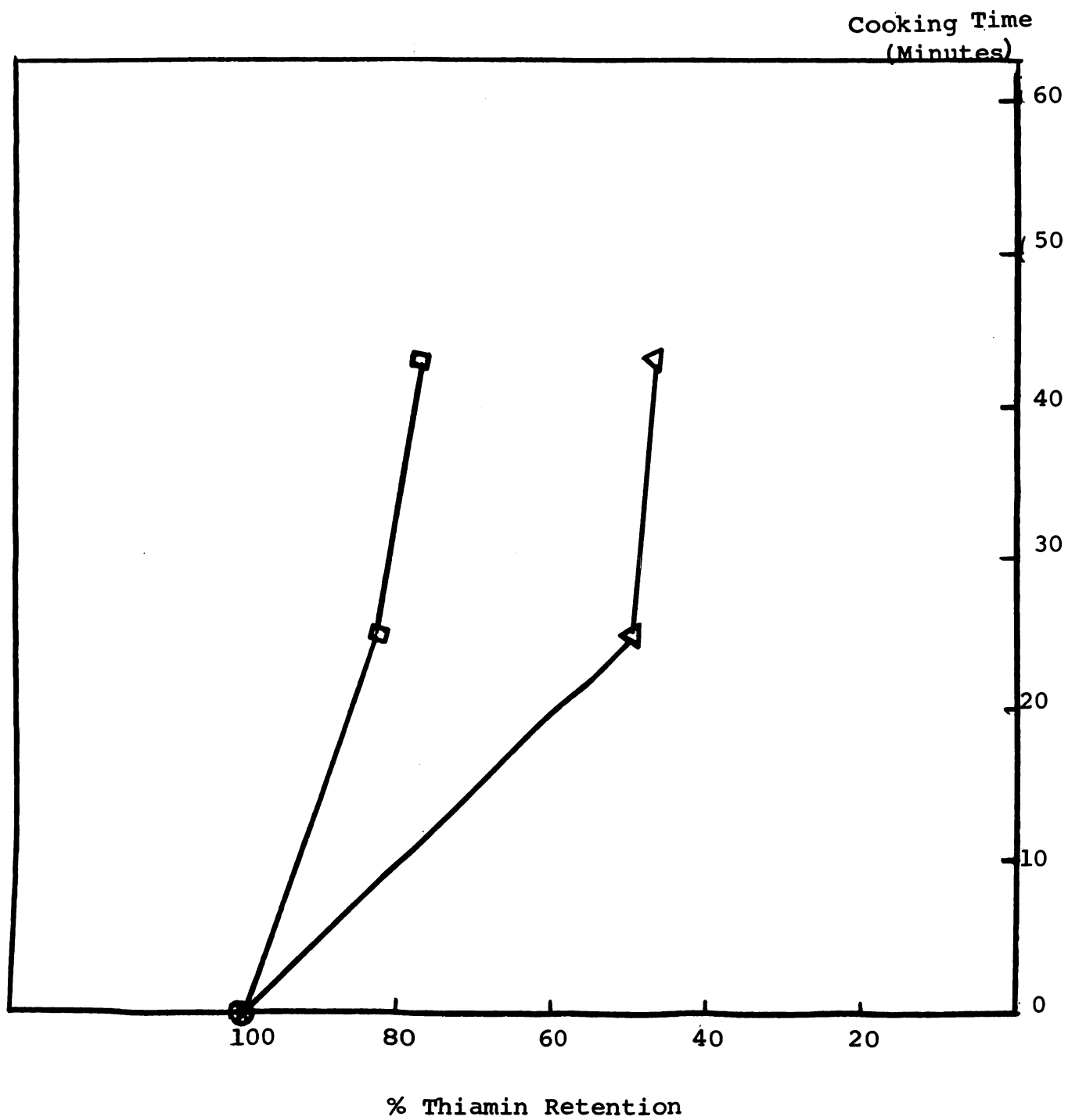
Values are based on the thiamin in raw
spinach



Values are based on the thiamin in
preboiled spinach

Figure 2. Retention of Thiamine During Cooking
of Obe Efo I

Figure 2.



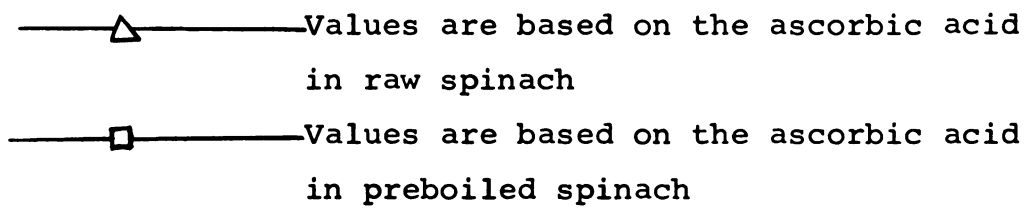
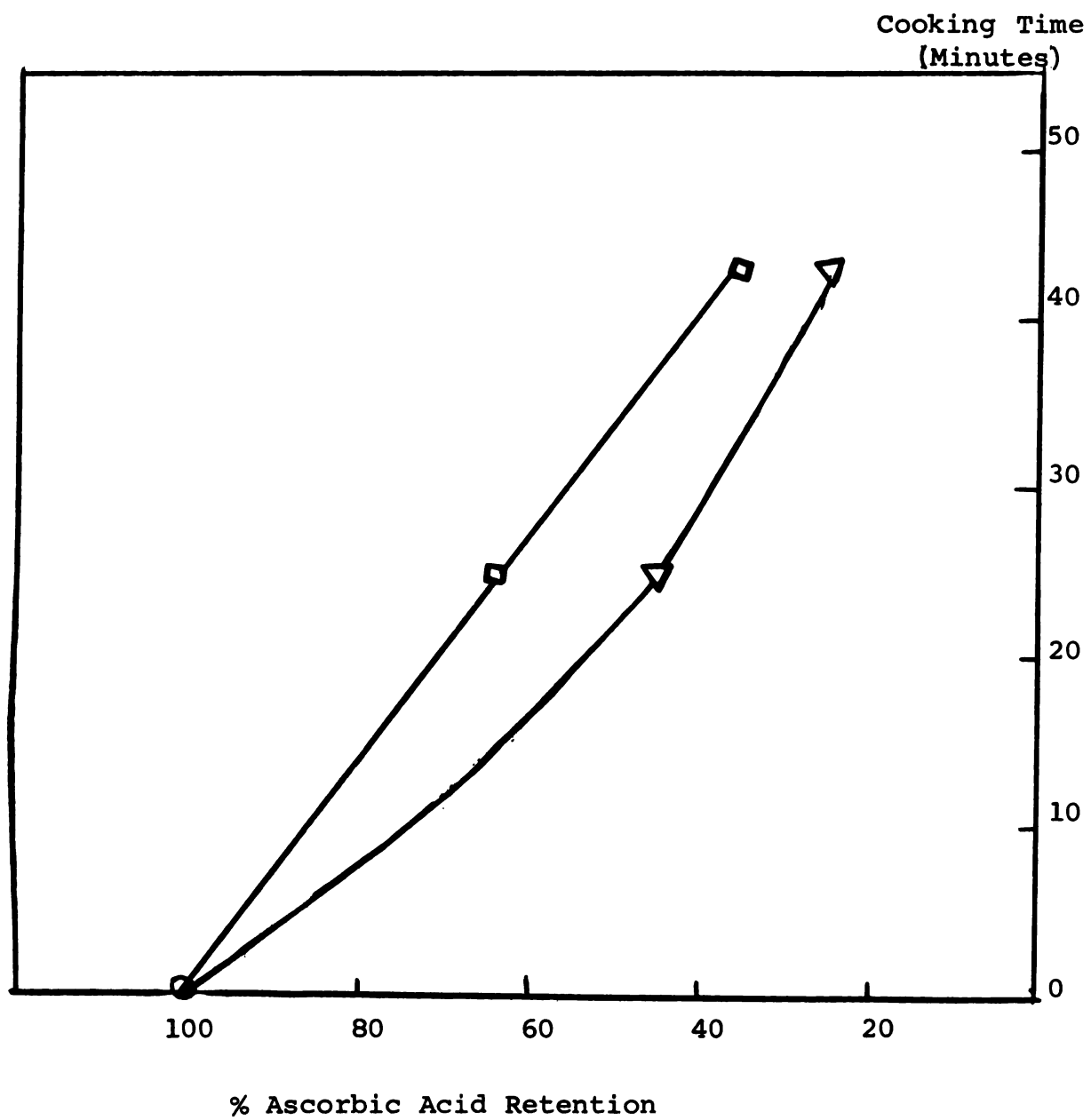


Figure 3. Retention of Ascorbic Acid During
Cooking of Obe Efo I

Figure 3.



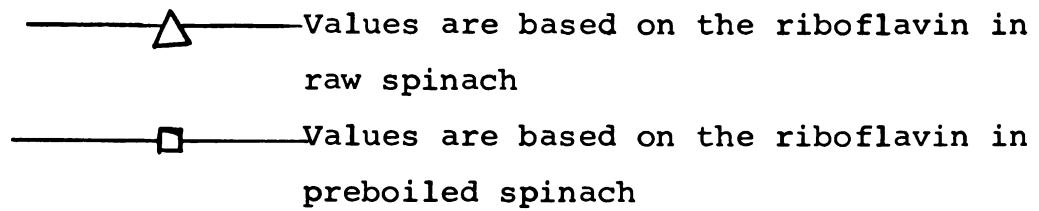
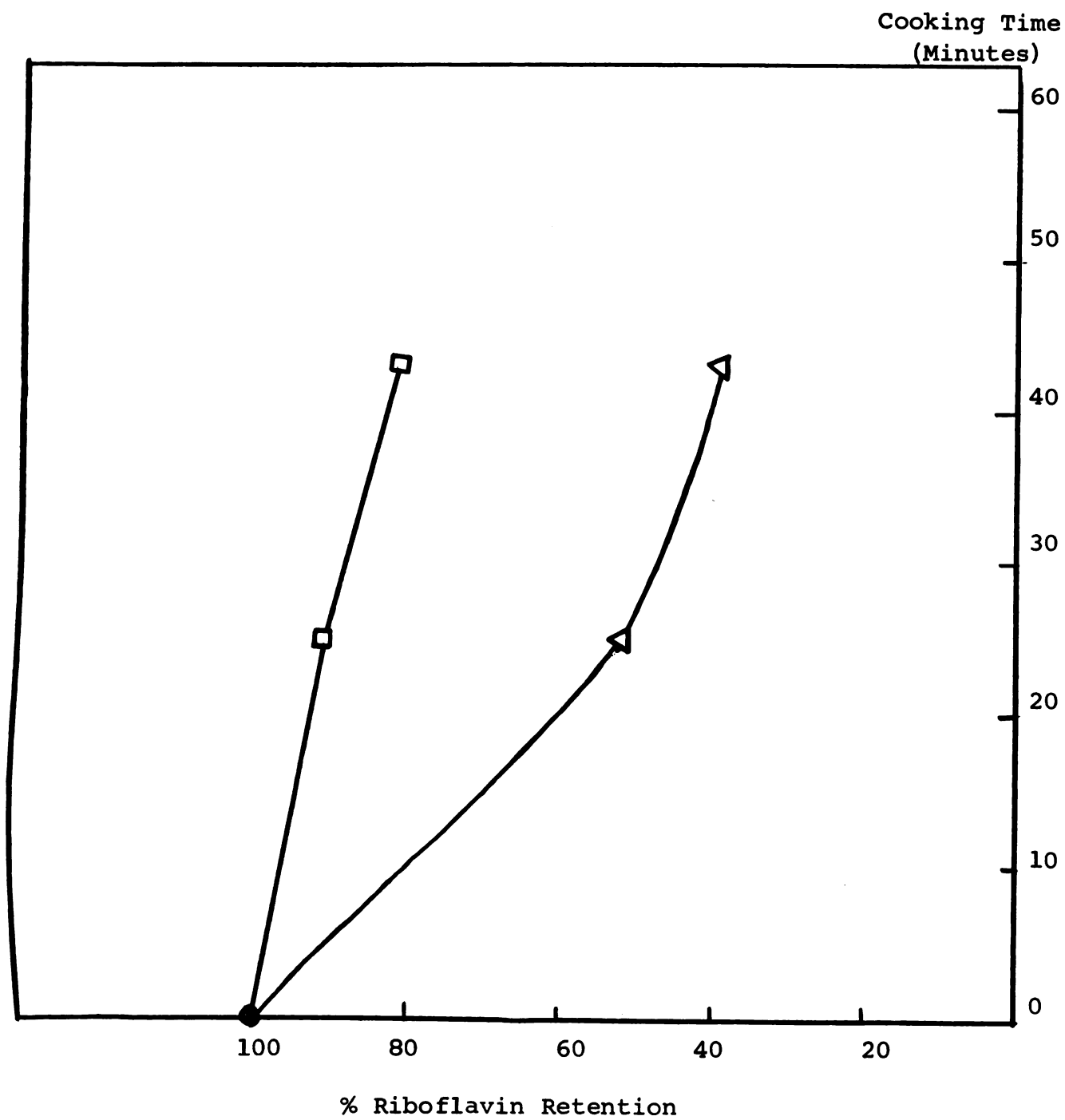


Figure 4. Retention of Riboflavin During Cooking
of Obe Efo I

Figure 4.



For Obe Efo II, sampling was done at only two stages; one was 11 minutes after the spinach was added and the other was immediately after the dried shrimp was added. For the first sampling, retention of thiamin, ascorbic acid, and riboflavin was 88.0%, 67%, and 85% respectively; while for the latter time, retentions were 86%, 45%, and 65% respectively (Table 4 and Figure 5).

For Obe Efo I, there was a sharp fall in the thiamin content by the time the shrimp was added which was not affected after 18 minutes of further cooking. When the computation for thiamin was made on the basis of the vitamin content of the preboiled spinach, the percentage retention was much greater (Table 3, Figure 2).

For ascorbic acid, retention decreased markedly throughout the preparation suggesting that ascorbic acid is more easily destroyed than thiamine by this method of cooking (Figure 3).

The retention of riboflavin was similar to ascorbic acid except that the slopes were less steep. The difference when retention was expressed on raw and preboiled spinach was the largest for riboflavin. This means that by reducing the loss of nutrients associated with such a procedure as pre-boiling the spinach will markedly improve the nutritional value of the food (Figure 4).

The destruction of vitamins in Obe Efo II was less than in Obe Efo I. For thiamin, most of the loss occurred during the last 15 minutes of cooking (Table 6 and Figure 5). Ascorbic acid destruction was much greater than for thiamin. Until the shrimp was added, the rate was almost a straight

Table 4. Retention of Vitamins in Obe Efo II During Cooking, and on Completion of Preparation.

Sauce Sample	Vitamin Retention						
	Thiamin		Ascorbic Acid		Riboflavin		% H ₂ O
	Mgs/100gms dry weight	% Re-tained	Mgs/100gms dry weight	% Re-tained	Mgs/100gms dry weight	% Re-tained	
Composite raw	(1) 0.43	(2) 0.55	(1) 140.49	(2) 179.67	(1) 0.708	(2) 0.91	
Sample Taken 11 Minutes After Spinach Was Added	0.48	88.0	114.44	63.69	0.77	84.62	81.33
Sample Taken Just After Shrimps were Added	0.37	86.04	62.54	44.52	0.46	64.97	76.78
End of Preparation	0.27	62.79	31.06	22.11	0.412	58.18	73.34

Note: (1) Concentration of vitamins in sauce after oil was added

(2) Concentration of vitamins in sauce before oil was added. This was used for calculating the amount in the sample taken 11 minutes after spinach was added.

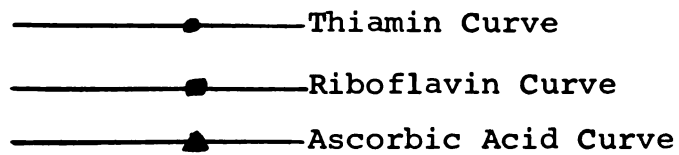
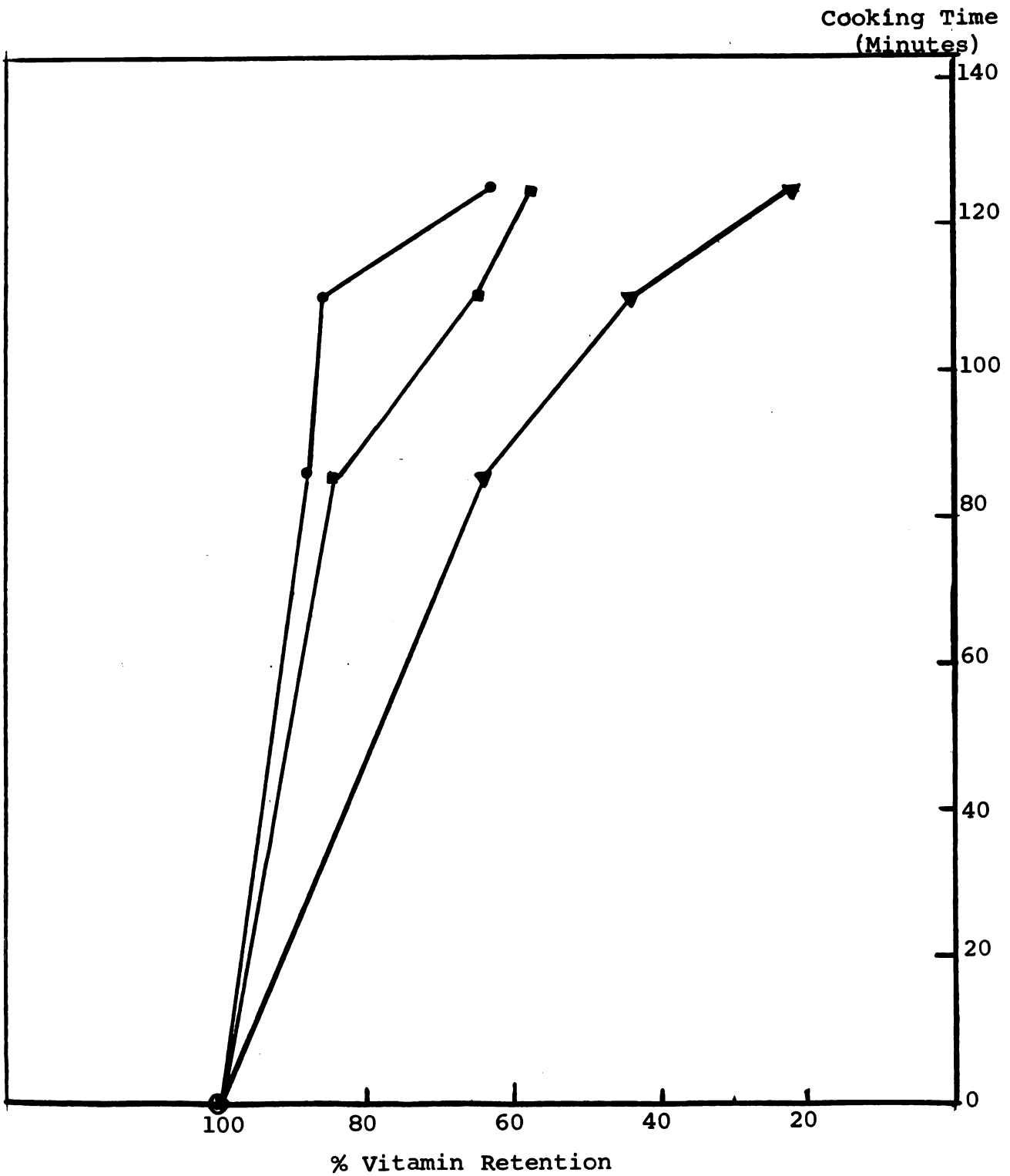


Figure 5. Retention of Thiamine, Riboflavin and
Ascorbic Acid During Cooking of
Obe Efo II



line, but it rapidly turned down after that. For riboflavin, the graph was similar to that for ascorbic acid but much more concave in nature.

Vitamins Retained in Cooked Sauces

When the cooking of the food was completed, the percentage retention for thiamin in Obe Efo I and II and the stew were 48%, 63% and 88% respectively (Table 5). The corresponding values for ascorbic acid were 25, 22, and 55%, while for riboflavin, they were 40, 45, and 81%.

Storage of Cooked Foods at Room Temperature

In Nigeria, sauces not completely consumed on the day of preparation are stored for one or two days. Since refrigeration is limited, the sauce is usually stored at room temperature and rewarmed before use. These conditions were imitated in the laboratory to find out how much of the vitamins were destroyed during storage.

Preliminary Study:

There was very little change in the thiamin content of Obe Efo I during storage. The principal loss occurred during preparation of the sauce (Figure 2).

For Obe Efo II, there was essentially no change with storage (Figure 1). The stew showed a gradual loss of these vitamins. Where 27, 37, and 42% losses of thiamin were recorded for the three storage times, 6, 21, 26 hours at room temperature.

Second Study:

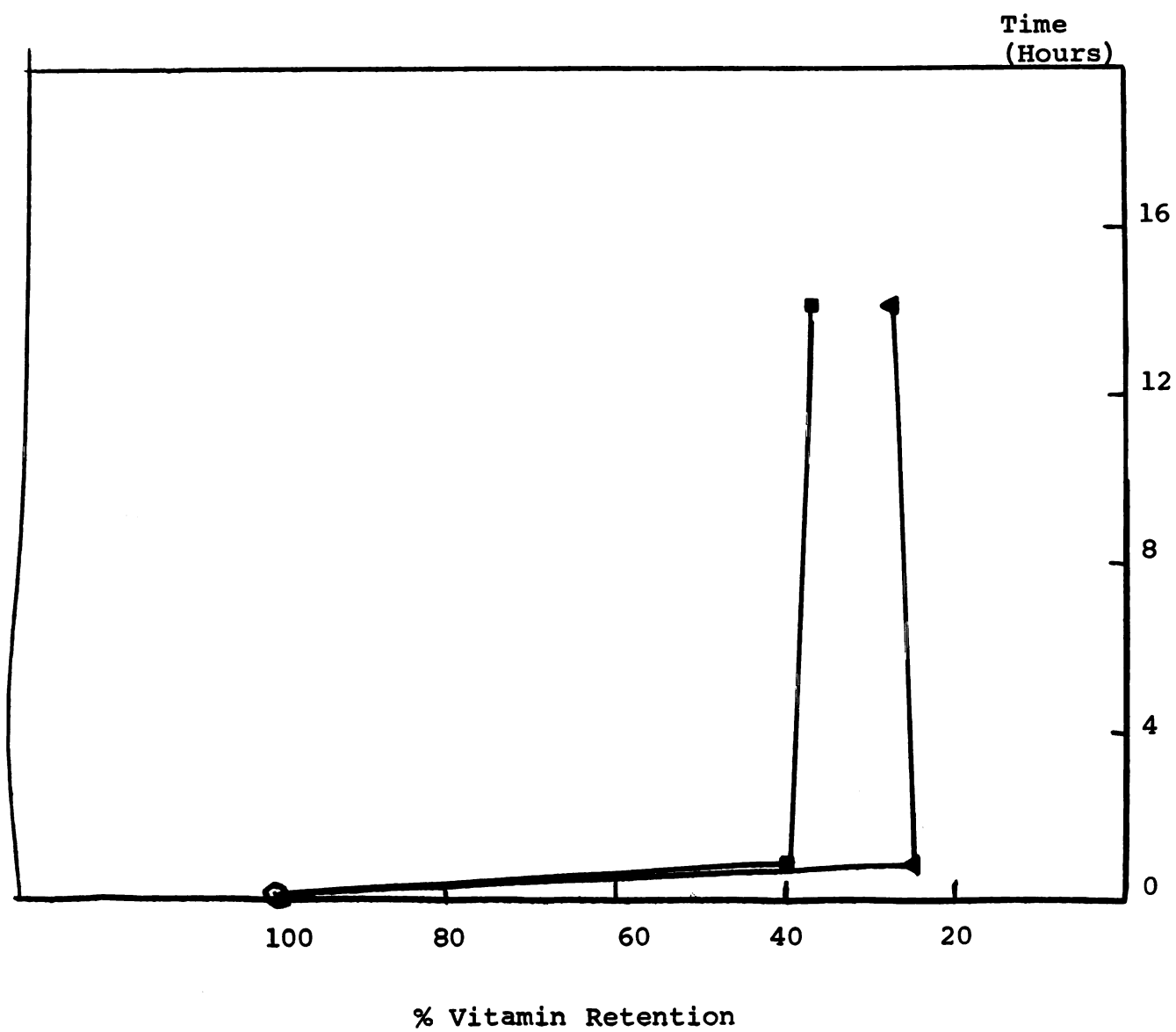
Storage of Obe Efo I for about 14 hours at room temperature resulted in no change in thiamin content. The value immediately after preparation and after 14 hours storage, was 48% for the same time intervals. The values for the retention of ascorbic acid were 25 and 26%, and for riboflavin, 40 and 37% respectively. These values are expressed on the basis of the raw spinach (Figures 1 and 6).

Obe Efo II gave the following retention values immediately after the sauce was prepared and after 17 and 22 hours of storage at room temperature: for thiamine, 63, 61, and 51%, for ascorbic acid, 22, 25, and 22%, and for riboflavin, 58, 61, and 50% respectively (Table 6 and Figures 1 and 7).

—■— Riboflavin Curve
—▲— Ascorbic Acid Curve

Figure 6. Ascorbic acid and riboflavin retention immediately after cooking and during storage of Obe Efo I at room temperature

Figure 6



—■— Riboflavin Curve
—▲— Ascorbic Acid Curve

Figure 7. Ascorbic acid and riboflavin retention immediately after cooking and during storage of Obe Efo II at room temperature.

Figure 7.

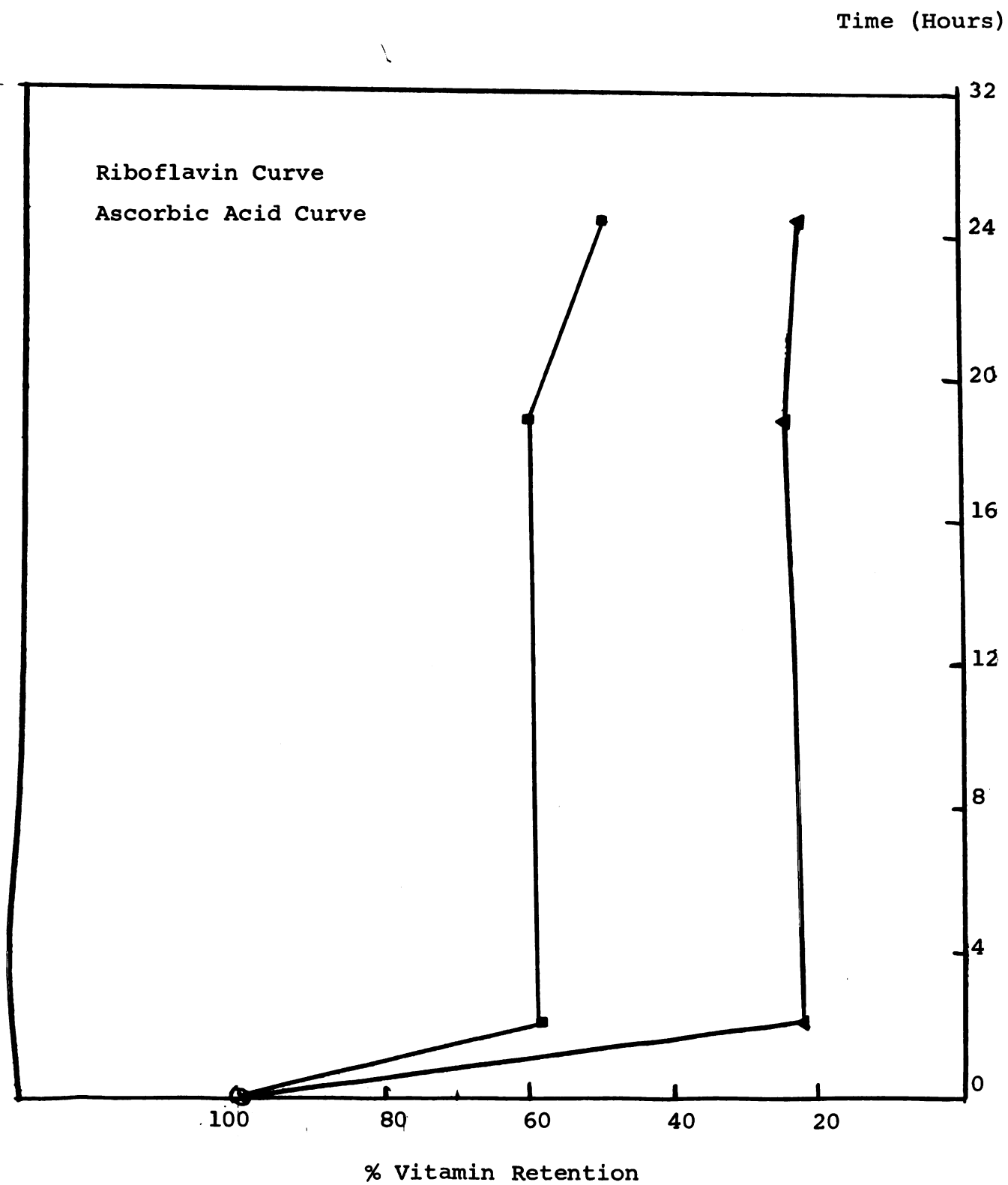


Table 5. % Retention of Thiamin, Ascorbic Acid and Riboflavin in the Cooked Sauces. All Values Expressed on a Dry Weight Basis.

Sauce	Thiamin		Ascorbic Acid		Riboflavin	
	(1)	(2)	(1)	(2)	(1)	(2)
Obē Efo I	47.62	77.30	25.03	35.81	39.88	81.43
Obē Efo II	62.79		22.11		58.18	
Stew	88.26		54.91		81.29	

Note: (1) Calculated using the vitamin values for raw spinach

(2) Calculated using the vitamin values for preboiled spinach

Table 6. Vitamin Retention of Obe Efo II After Storage at Room Temperature (83°F)
Values are Expressed on Dry Weight Basis

Sample	Thiamin		Ascorbic Acid		Riboflavin	
	Mg/100gms	% Re- tention	Mg/100gms	% Re- tention	Mg/100gms	% Re- tention
Composite Raw	0.43		140.49		.708	
End of Preparation	0.27	62.79	31.06	22.11	.412	58.18
Cooked Sauce Stored for 16 3/4 Hours	.263	61.25	34.66	24.67	.43	60.71
Cooked Sauce Stored for 22 Hours	.315	72.25	30.96	22.04	.35	50.00

DISCUSSION

OBE EFO I had the highest amount of each vitamin in the raw composite, but it retained the least percentage of each vitamin. However, in absolute term, the mgs of vitamins retained per 100 gms dry weight in this source was much higher than in any of the other sauces (Tables 5, 6).

Despite this, the loss of nutrient in Obe Efo I is a tremendous one. For example, the ascorbic acid which "disappeared" during the preparation of Obe Efo I and Obe Efo II and stew were 258, 109, and 27 mgs per 100 gms respectively. Initially the sauce composite had 344, 140, and 79 mgs/100 gms on dry weight basis.

From the foregoing, one can see that the severity of the method of preparation resulted in a great loss of the nutrients of Obe Efo I. Secondly, this sauce is composed mainly of vegetables and fruits, all of which, except spinach, are homogenized and used in the sauce without any preliminary handling. The spinach in the first vegetable sauce is more than half of the total quantity of the ingredients in the sauce, and also contains a high amount of all the vitamins. It is the item that is preboiled and rinsed before incorporation into the sauce.

The large amount of spinach in this sauce probably accounts for a large share of the vitamin destruction which occurred during the preparation of food. The preboiling of the spinach resulted in a large loss of vitamin, partly due to its high concentration of vitamins and to the large amount of

this vegetable incorporated in the sauce. The large surface area of the spinach facilitated the destruction of the heat labile nutrients. This can be shown by the fact that 95% of the vitamin C was retained in asparagus during blanching, while only 67% in spinach under similar conditions (E. J. Cameron, 1964).

Spinach is the largest ingredient in 'Obe Efo' II, followed closely by meat which contains less thiamin and riboflavin than spinach and very little ascorbic acid. Thus, meat dilutes the mgs thiamin/100 gms of the composite compared with the first vegetable sauce. Since there is no preboiling of the spinach for 'Obe Efo' II, cooking time is more important. Since the loss of vitamin during cooking is gradual, it could be reduced considerably by shortening the cooking time.

The stew retained the highest percentage of each vitamin. However, because of the large amount of meat in it, the amount of vitamin in the stew composite is much lower than any of the vegetable sauces. The method of cooking the stew is similar to that employed for 'Obe Efo' II except that spinach was excluded. Since vitamin retention in the stew remains high after cooking, it stresses the point that it should be easy to reduce the loss of vitamin in 'Obe Efo' II by shortening the cooking period also.

The problem of storage needs further investigation. However, from this study one can say that in the case of the two vegetable sauces, especially 'Obe Efo' I, the loss of vitamin is already so great by the end of preparation that there is not much left to be lost during storage. Therefore,

storage of Obe Efo I at room temperature for up to 19 hours after preparation did not result in any appreciable change in vitamin content. This was also true of Obe Efo II. Thus, there was very little difference in vitamin content of samples stored at room temperature for 21 hours.

Nitrogen values for Obe Efo I at the end of cooking and after 13 hours of storage at room temperature were 3.42 and 3.17% respectively, while for Obe Efo II, values at the end of preparation, and after 16 3/4 hours and 22 hours were 6.52, 6.36 and 6.21% respectively under the same conditions of storage.

These values showed a difference of approximately 3% for Obe Efo I and 2% in the case of Obe Efo II. These differences are within experimental error for the micro kjheldah method, and moreover, they can be explained on the basis of slight variations in aliquot samples. The nitrogen in the sauces apparently did not show much change with storage for the period of time studied. From the foregoing, a few suggestions as to the ways of reducing the loss of vitamins in these sauces during preparation can be made.

Much of the nutrient in Obe Efo I will be conserved if the preboiling of the leafy vegetable, which contains the highest concentration of vitamins, can be eliminated, or the washing of these vegetables after preboiling. If pre-boiling cannot be eliminated completely, the amount of water used in boiling should be reduced considerably and so also must be the length of time for which preboiling is done.

The practice of washing vegetables after boiling is to remove sand and extraneous materials which accompanied these vegetables from the farm. Thorough washing of vegetables

immediately after harvesting will go a long way to reduce washings during household cooking.

Loss of nutrients in Obe Efo II will be much reduced if the cooking period is shortened, especially the time after the spinach has been added.

In the study, the stew seemed to retain much of its vitamin content at the end of preparation. However, considering that meats in Nigeria are of less tender cuts than the one used in this study (Nigerian Nutrition Survey, 1965) and thus they may be subjected to much longer periods of cooking, then the length of the cooking period becomes an important factor. The use of locally available meat tenderizers like enzymes from papaya and pineapples would help in reducing cooking time of the meats.

Calculations of the contributions of these foods to the nutrients intake were made from data of dietary studies done by different investigators at different times in Nigeria. These calculations are based on the minimum daily requirement, not the recommended daily allowance.

B. M. Nicol (1959) determined the calorie requirements of Nigerians of different age groups in seven Nigerian villages. Thiamin and riboflavin requirements are based on calorie intake. Based on Nicol's estimates, children 4-6 years and weighing 12.90 kg require 1585 calories/day. Their minimum thiamin, riboflavin, and ascorbic acid requirements will be 0.32 mgs, 0.63 mgs, and 30.0 mgs respectively. Seven to nine year olds weighing 22.49 kg and consuming 1928 calories per day will need 0.4 mg, 0.8 mgs, and 30 mgs of thiamin, riboflavin, and ascorbic acid respectively. Ten to twelve year olds

of 30.47 kg body weight and receiving 2303 calories per day need 0.46, 0.92, and 30 mgs of the three vitamins respectively, while males who are 13-70 years old, of 57.27 kg body weight and consuming 2527 calories per day will need 0.51, 0.76 and 30 mgs of the three vitamins respectively. Females of the same age, weighing 49.94 kg and receiving 2036 calories per day will need 0.41, 0.61, and 30 of the vitamins as listed above respectively. An adult male consuming 193.21 gms of Obe Efo II with rice at a meal will receive 0.14, 16, and 0.21 mgs thiamin, ascorbic acid and riboflavin from the sauce alone, and this will be approximately 28, 53, and 28% of the minimum daily requirement for these vitamins respectively (Nigerian Nutrition Survey, Table 10, page 82).

Seven to ten year olds receiving 67.36 gms of the stew with rice in the school lunch program will receive 0.035, 11.52, and 0.053 mgs thiamin, ascorbic acid and riboflavin respectively. This would furnish 9, 38, and 7% of the minimum daily requirements of these vitamins respectively. Ten to twelve year olds receiving the same amounts as the above children will have 8, 38, and 6% of their minimum daily requirements furnished by the stew respectively (Nigerian Nutrition Survey).

John Mc'fie (1967) did a study on the nutrient intakes of Urban dwellers in Lagos, Nigeria. From Table 3 of his paper, it was possible to calculate how much vitamin the civilians would be furnished by the items which go into each of the three foods. These excluded fresh fruit but included dried fish. The serving for Obe Efo I and stew were combined because this is the way they would be eaten, with "fofoo."

According to his study, adult males eating 50 gms of Obe Efo I, along with 91 gms of the stew will receive 16.0%, 76%, and 15% of thiamin, ascorbic acid and riboflavin respectively. While adult females consuming 40 gms of Obe Efo I in combination with 71 gms of stew will receive 16%, 63%, and 15% thiamin, ascorbic acid, and riboflavin. Ten to twelve year olds receiving 30 gms of Obe Efo I, along with 51 gms of stew will be provided with 10%, 43%, and 7% of thiamin, ascorbic acid, and riboflavin respectively. When 30 gms of Obe Efo I in combination with 56 gms of stew is given to seven to nine year olds, they will receive about 13% of thiamin, 46% of ascorbic acid, and 9% riboflavin respectively. Four to six year old consuming 30 gms of Obe Efo I and 55 gms of stew will receive 15, 46, and 11 per cent of thiamin, ascorbic acid, and riboflavin respectively. One hundred forty one grams of Obe Efo II would furnish 20, 39, and 53 per cent thiamin, ascorbic acid, and riboflavin at one serving to adult males. To seven to nine year olds, 79.41 gms of the same food would furnish 15, 21, and 11 per cent of the three vitamins respectively while ten to twelve year olds would be provided with 13, 22, and 9 per cent of the three vitamins respectively from the same amount of food.

On wet weight, Obe Efo II provides more thiamin and riboflavin than Obe Efo I and the stew when eaten in combination, while the latter provides more ascorbic acid.

These values, however, indicate that much of the ascorbic acid consumed by the people must come from sources other than the vegetable sauces and the stew. Kola nuts have been reported to contain high levels of this vitamins, and so, are

fruits like oranges and mangoes, etc., which are eaten as snacks during the day. Kola nut especially, is chewed by more than half of the adult population, hence, the high plasma levels of this vitamin found in the various nutrition surveys.

SUMMARY

Many investigations have been done in Nigeria regarding nutritional status of the people. It is evident from these studies that riboflavin is deficient, thiamin inadequacy is acute, while ascorbic acid is found to be adequate judged by the high levels found in the plasma.

Various indigenous household cooking practices seem to indicate that much of the nutrients in foods may be lost before they are actually consumed. One such practice is the preboiling and washing of the vegetables after boiling before incorporation into sauces. These operations are done to remove stones, and other unwanted materials from the green vegetable, as well as reduce the greenish-brown colloidal consistency which unwashed vegetables are said to impart to the sauce, which makes the vegetable unacceptable to some people if this is retained. This study was therefore devoted to finding what alterations would occur to the nutrients, namely, thiamin, riboflavin, and ascorbic acid when foods are subjected to these methods of food preparation.

Three types of sauces were prepared, and chemically analysed for these nutrients, namely, Obe Efo I and II, which employed two methods of preparation and a stew.

Obe Efo I had the green vegetables preboiled and washed in cold water twice. The vegetable was then drained and cut up. It was later incorporated into a sauce base made from homogenized tomatoes, onions, peppers, and oil, with salt to taste.

The green vegetables in Obẹ Efo II was cut up raw and incorporated into a sauce base which comprised of the ingredients used in Obẹ Efo I along with meat cut up into stew sizes. The whole preparation lasted two and two-thirds hours.

The stew was made from cut up meat which was boiled for 50 minutes before the other ingredients were added; they were the same as used for Obẹ Efo I. No leafy vegetable was used in its preparation.

- (1) The findings from the study show that alterations in the nutrient contents of the foods depended very much on the severity of the method of preparation.
- (2) The effects of preboiling and excessive washing of boiled vegetables which may lead to the destruction and leaching out of vitamins, as well as effects of long cooking periods are marked in those sauces where such methods are employed. They are much reduced in those sauces where less prolonged treatment of the ingredients is done prior to cooking.
- (3) Obẹ Efo I is subjected to all the three operations and so it lost the highest percentage of its vitamins.
- (4) Obẹ Efo II is exposed to a long cooking period only and loss of vitamins is slightly reduced.
- (5) The stew employs long cooking periods but the primary ingredient is meat whose vitamin content is more stable due to the small surface area

exposed to heat as against spinach in the other sauces. For this reason, the percentage vitamin retention in the stew is higher than in any of the other sauces, but the mgs/100 gms is much lower because of low initial amount in the raw composite.

- (6) It appears that investigations concerning storage of the sauces at room temperature will become necessary if the losses of nutrients in the sauces are reduced to a minimum by the end of preparation.

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APPENDIX

Preliminary Study

Table 7. Mgs of Vitamin in 100 gms of Each of the Ingredients.

Ingredients	% Moisture	Mgs Thiamin /100gms Wet Basis	Mgs Thiamin /100gms Dry Basis	Mgs Ascorbic Acid/100gms Wet Wt. Basis	Mgs Ascorbic Acid /100gms on Dry Weight Basis
Spinach	96.15	0.110	1.43	29.68	319.10
Meat	62.88	0.046	0.12	1.51	4.06
Onions	95.53	0.025	0.28	3.84	91.94
Pepper	9.50	0.496	0.55	17.93	19.82
Tomatoes	95.80	0.062	0.97	9.77	232.49
Shrimp	13.66	0.051	0.059	6.44	7.46

Preliminary Study

Table 8. Obe Efo I: Mgs Vitamin Contained in the Raw Ingredients
Used for the Sauce

Ingredients	Wt. On Wet Basis Gms	Wt. On Dry Basis	Mgs Thiamin in Total	Mgs Ascorbic Acid in Total
Spinach (Raw)	920.00	85.56	1.22	273.03
Onions	269.50	11.24	0.032	10.33
Pepper	3.00	2.72	0.014	0.54
Tomato	209.30	8.80	0.085	20.44
Shrimps	20.00	17.27	0.01	1.29
Oil	90.34	90.34	-	-
TOTAL	1512.14	215.92	1.36	305.62
Mgs Vitamin/100gs of Composite			0.63	141.50

Preliminary Study

Table 9. Obe Efo II: Mgs Vitamin Contained in the Raw Ingredients Used for That Sauce

Ingredients	Wt. On Wet Basis Gms	Wt. On Dry Basis Gms	Mgs Thiamin in Total on Dry Wt. Basis	Mgs Ascorbic Acid in Total
Spinach	1147.00	106.67	1.5	340.39
Meat	1205.00	448.39	0.56	20.54
Onions	389.00	16.23	0.046	14.92
Pepper	11.00	9.95	0.055	1.97
Oil	180.68	180.68	-	-
Tomatoes	210.00	8.83	0.085	20.52
Shrimps	30.00	25.90	0.015	1.93
TOTAL	3172.68	796.65	2.28	400.28
Mgs Vitamin /100gms of Composite			0.28	50.30 mgs.

Preliminary StudyTable 10. Stew: Mgs Vitamin Contained in the Raw Ingredients
Used for the Stew

Ingredients	Wt. On Wet Basis	Wt. On Dry Basis	Mgs Thiamin in Total On Dry Wt Basis	Mgs Ascorbic Acid in Total
Meat (Beef)	1386.0	514.46	0.64	20.88
Onions	379.0	15.81	0.045	29.07
Pepper	12.0	10.86	0.06	2.15
Tomatoes	329.30	13.84	0.13	48.28
Oil	271.03	271.02	-	-
TOTAL	2377.03	825.99	0.88	100.37
Mgs Vitamin /100gms Composite			0.106	12.15

Second Study

Table 11. Mgs of Vitamin in 100 gms of Each of the Ingredients.

Ingred- dients	% Moisture	Mgs Thia- min/100gms Wet Basis	Mgs Thia- min /100 gms Dry Wt Basis	Mgs Ascor- bic Acid/ 100gms Wet Basis	Mgs Ascor- bic Acid/ 100 gms Dry Wt Basis	Mgs Ribo- flavin/ 100gms Wet Wt Basis	Mgs Ribo- flavin/ 100gms Dry Wt
Spinach	96.30	0.0690	1.86	22.27	601.89	0.104	2.80
Pepper	7.30	0.57	0.61	106.64	115.03	0.89	0.96
Shrimps	12.40	0.058	0.066	8.168	9.32	0.71	0.81
Tomatoes	93.94	0.056	0.92	39.05	644.39	0.03	.50
Onions	91.91	0.020	0.25	36.78	14.76	0.023	0.28
Meat (Beef)	68.04	0.060	0.19	1		0.134	0.42
Spinach (Boiled, Washed & Squeezed)	95.51	0.037	0.82	16.43	365.68	0.08	1.77

Second Study

Table 12. Qbe Efo I: Mgs of Vitamin Contained in the Raw Ingredients Used for the Sauce

Ingredients	Wt On Wet Basis Gms	Wt On Dry Basis Gms	Mgs Thiamin in Total	Mgs Ascorbic Acid in Total	Mgs Riboflavin in Total
Spinach (Raw)	1576	116.6	2.17	701.8	3.26
Spinach (Preboiled & Washed)	866	77.82	0.64	284.50	1.38
Tomato	524	31.75	0.29	204.59	.16
Onion	334	33.78	.083	153.58	.095
Pepper	13	12.05	.074	13.86	.12
Oil	99	99.0	-	-	-
Shrimps	22	19.27	0.013	1.80	.16
TOTAL (1)	2568	312.45	2.63	1075.63	3.80
TOTAL (2)	1858	273.67	1.104	658.32	1.92
Mgs Vit/100 gms of Comp.			(1) 0.84 (2) 0.52	(1) 344.20 (2) 240.55	(1) 1.22 (2) 0.70

1) Total wt using the quantity of raw spinach.

2) Total wt using the quantity of spinach after preboiling and washing.

Table 13. Obe Efo II: Mgs of Vitamin Contained in the Raw Ingredients
Used for the Sauce

Ingredients	Wt On Wet Basis In gms	Wt On Dry Basis In gms	Mgs Thiamin in Total	Mgs Ascorbic Acid in Total	Mgs Riboflavin in Total
Meat	1364	436.0	0.83	64.38	1.83
Spinach	1767.0	133.0	2.47	792.14	3.72
Oil (Peanut Oil)	190.0	190.0	-	-	-
Pepper (Dried)	13.0	12.05	0.074	13.86	0.12
Onions	450.0	45.51	0.11	206.91	0.13
Tomatoes	368.0	22.3	0.21	143.70	0.11
Shrimps	37.0	32.41	0.021	3.02	.26
TOTAL (1)	4189.0	871.25	3.72	1224.01	6.17
TOTAL (2) Before oil was added	3999.0	681.25	3.72	1224.01	6.17
Mgs Vitamin /100gms of Composite			(1) 0.43 (2) 0.55	(1) 140.49 (2) 179.67	(1) 0.71 (2) 0.91

(1) Refers to Values computed without the oil.

(2) Refers to Values with oil.

Second Study

Table 14. Stew (Alapa): Mgs of Vitamin Contained in the Raw Ingredients Used for the Stew.

Ingredients	Wt On Wet Basis Gms	Wt On Dry Basis	Mgs Thiamin in Total	Mgs Ascorbic Acid in Total	Mgs Riboflavin in Total
Meat (Beef)	1247.00	398.67	0.76	58.84	1.67
Onions	562.00	68.09	0.17	309.56	0.19
Pepper	19.00	17.61	0.11	20.26	0.17
Tomato	517.00	31.33	0.29	201.89	0.16
Oil	229.00	229	-	-	-
TOTAL	2574.00	744.70	1.33	590.58	2.19
Mgs Vitamin /100gms of Composite			0.18	79.31	0.294

Temperature Chart During Cooking

Table 15. Obe Efo I

Food Item	Time of Heating in Minutes	Temp °C
Water	Zero time	22° C
First lot of Spinach	14	98° C
First lot Removed	4	80° C
Water	4	90° C
Second lot of Spinach added	8	90° C
Spinach Removed	2	96° C
In another sauce pan, onion & to- mato & pepper	Zero time	20° C
Just before spi- nach was added	15	90° C
Addition of Shrimps	5	48° C
Preparation Finished	18	92° C

Total Time Each Item Was
Heated During Cooking

Item	Time in Minutes
Spinach	30
Tomato	43
Onion	43
Pepper	43

Note:

It is difficult to record one temperature as the cooking temperature for any of the sauces. This is because various ingredients were added at different times and this lowered the temperature at each addition before the sauce was heated up again.

Temperature Chart While Cooking

Table 16. Qbe Efo II

Item Added	Time in Minutes	Temp °C	Total Time for Which Each Item was Heated	
Meat + Water + Salt	Zero Time	22°C	<u>Item</u>	<u>Time</u>
--	30	98°C	Meat	2 Hours
Tomato + Onion + Pepper	35	48°C	Pepper] Tomato] Onion]	1 Hour 25 min.
--	30	98°C	Spinach	50 min.
Spinach was Added	10	30°C		
--	14	98°C		
Addition of Shrimps and oil	16	92°C		
Preparation Finished	20	90°C		

Temperature Chart During Cooking

Table 17. Stew

Item Added	Time in Minutes	Temp °C	Total Time Each Item was Heated During Cooking	
Meat + Salt + Water	Zero Time	22°C	<u>Item</u>	<u>Time</u>
	7	40°C	Meat	1 Hr 32 min.
	7	94°C	Pepper]	
	36	98°C	Tomato]	42 min
Onion + Tomato in another Sauce Pan	Zero Time	18°C	Onion]	
--- Pepper + Stock From Meat	10 5	90°C 92°C		
Preparation Finished	17	96°C		

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