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Nutrient contents of *L. lycopersicum* at different ripening stages: A determinant for bacteriological spoilage

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ABSTRACT

Lycopersicon lycopersicum (tomatoes) is a vegetable of the family solanacease with international popularity and important ranking second to potatoes. The vegetable had been found to contain some important nutrients that the body needs and therefore the fruit has been of high culinary use at homes and industrial work locations as food. In this work three varieties of tomatoes (Var. commune, var. validum and Var. pyriforme) were subjected to biochemical analysis at three different ripening stages and spoilage rates were followed simultaneously. The result of the analysis showed no significant ($P>0.05$) difference in the moisture, glucose, protein and fat contents between the three varieties. The result also indicated gradual increases in the moisture, protein and fat contents as fruit transited from the one stage to another, but there was a significant ($p<0.05$) decrease in glucose content. The rate at which the tomatoes spoilage occurred also increased significantly ($p<0.05$) as it transited along the stages. This therefore indicates nutrient-ripening stage effect on storage and spoilage of vegetable. However, there was no significant ($p>0.05$) variation between the varieties.

Key words: Nutrient, *Lycopersicon lycopersicum,* Var. commune, Var. validum, Var. pyriforme, Climacteric plant, Bacillus coagulans.

INTRODUCTION

Lycopersicon lycopersicum commonly known as tomato is a vegetable of the family solanacease. It is one of the most important vegetables in the world. Tomato is a native of the present Peru-Bolivia Ecuador region of the South America, in which continent the plant still may be found growing as wild plant (Tindall, 1983). The plant was carried to Europe by Spanish explorers and accepted as garden ornamental in 1800 who called it 'love apple' (Douglass et al, 1982). The plant is cultivated extensively in Sudan and Guinea Savannah tropical and temperate ecological zones around the world (Bodunde, 1983).

It is also one of the leading vegetable grown in United States of America and Canada (Nonnecke, 1992). Based on information from food and Agricultural organization (FAO) of the United Nations, statistics for world wide tomato production shows that the production is throughout the world with united states and Hungary as highest and least producing area respectively.

In Nigeria as well as many other African countries, it seems to be among major vegetables grown per consumption and with a significant market share (Yayock, 1988). The commodity is of high demand in the southern states, while production is carried out mostly in northern state because of the favourable climatic conditions and landmass.

There are numerous varieties of tomatoes, some of which include var. cerasiforme, var pyriforme, var grandifolium, var validum and var

commune (Tindall, 1983). Yayock (1988) identified other new developed breed in Northern Nigeria which include cirio 56, harvester, marzanino, Piacenza 0164 and Ronita. Cultivars la – Donitza, Ife 1 and anterpriser are fresh market types. Other varieties are also found around the world including the new breeds.

Ripening of fruit is a biochemical dramatic event often involving rapid changes from toughness to tenderness, from bitterness to sweetness and from chlorophyll green to spectral range of colours of ripe fruits. At the point of ripeness the seeds within the fruit have matured. Respiration rates in tomato fruits are indicative of the rate of compositional changes in the ripening process. Respiration rates are usually measured as milligram-carbondioxide per kilogram material per hour. High respiration rate means high rate of compositional changes.

John and Wathorn (1981) related that a sharp rise in respiration rate which coincide with the normal obvious changes of colour, texture and flavor is associated with ripening. One of the most striking phenomenons associated with the ripening of many fruits is referred to as climacteric, of which tomato is classified under (John et al, 1981)

Tomato classification as respiration climacteric plant is based on its respiratory behavior during ripening as confirmed by (Showfelt, 1992). This respiratory climacteric episode is the ability of fruits or vegetable to continue ripening after detachment from the parent plant.

Tomato as a food substance is known to contain some nutrients that is required by the body and must be present in the diet of healthy people. Deficiency of any nutrient leads to a state of malnutrition. Nutrient may include Carbohydrates, Fats, vitamins, proteins, moisture, mineral elements etc. Nutrients are considered based on function and their chemical compositions, which are closely associated. Tindall (1983) deduced that tomato is a rich source of essential minerals and vitamins. Acids like citric acid, malic acid and amino acids usually glutamic, methionine and s-methylmethionine present in tomato are the major acid composition (wills et al, 1989). Nutrients functions depend on the chemical composition. On a general note, nutrients are found to promote materials for growth and repair of tissues and supply the body with the energy required to perform external and internal activities.

Ngoddy *et al* (1985), defined nutrients as chemical components of food that produce energy, promote growth, repair tissues or regulate their processes.

Generally, because of the acidic content of fruits few bacteria infest them. The degree of infestation varies with the kinds of substances. Vegetable salads such as celery, bean sprouts etc. were found in the year (1995) to contain 10^6- 10^7 bacteria per gram, with number greater than 10^7 not common (Jay, 1996). However tomato fruits have a very low PH (3.8-4.5) thus its spoilage is similar to that of fruits, although bacterial spoilage also occur (Banwart, 1989). Tomato fruits and tomato products are subject to microbial contamination during processing, transportation and storage, Tanner (1938). Banwart (1989) attributed spoilage to the presence of and growth of *Bacillus Coagulans* which wither, survived normal heat processes or decontaminate the products.

However Cameroon (1982) had encountered some facultative thermophilles in canned tomatoes and tomato juice at low acidity.

Frazier and Westhoff (1978) reported that the microbial count on dried vegetables ranges from negligible ambers to millions per grams and the genera of bacteria found include *Escherichia, enterobacter, bacillus, clostrdium, micrococcus, pseudomonas and streptococcus*. Banwart (1989) observed the species of *micrococcus, flavobacterium, streptococcus pseudomonas, lactobacillus and enterbacter* to be the dominant spoilage organisms in frozen tomato products.

Researches on tomatoes have covered many aspects of its growth, its environmental requirements, pest and diseases control, weed control, variety screening, variety recommendation, variety improvement and yield enhancement (Bodunde, 1993)

However, lately less attention has been focused on the nutrients contents of the fruit at different ripening stages, characteristics of the tomato fruit. Fruit shape, number of locules per fruit as well as number of seeds per fruit are among the economically important characteristics that determine the suitability of the fruit for either fresh market or processed one. For instance, number of locule per fruit was reported to be important as a source of firmness which provides resistance to mechanical damage. While the number of seeds per fruit might contribute to the feasibility of producing hybrid tomato (Yordanou, 1984)

Therefore, the objective of this work is geared toward analyzing some of the nutrients contents of the fruit at different ripening stages, (i.e. green mature ripe, medium ripe and red ripe) and to see the relationship between these stages of ripening and rate of bacterial spoilage of the fruit. This study will also identify the ripening stages that will have the higher value nutrients content. Finally, it makes a comparative study of nutrient-ripening stage effect on the rate of spoilage between three different varieties (var. communes, var. validum and var. pyriforme).

MATERIALS AND METHODS

Collection of *Lycopersicon lycopersicum*

Tomato fruits were harvested directly into sterile white polyethene bags from a farm in Nassarawo village in Girei Local Government of Adamawa state, Nigeria. The stages of ripening were determined by physical observation of the changes in colour of the *L. lycopersicum* fruits. Fresh, injury free *L. lycopersicum* showing no signs of infection were collected by hand picking into the sterile polyethylene bags. The *Lycopersicon lycopersicum* samples were transported to the laboratory immediately after collection for analysis.

Preparation of tomato fruits for glucose and protein determination

The *Lycopersicon lycopersicum* fruits were sliced with a clean knife and homogenized using a blender. The homogenate was put into a test tube and centrifuged at 300rpm for 10 minutes. The supernatants obtained were used for glucose and protein estimations.

Estimation of glucose and protein

Glucose estimation was carried out using glucose oxidase method, while Protein was estimated by trichloroacetic acid method (Trinder 1969).

Moisture and fat contents

Moisture content was determined gravimetrically using drying method and fat content was determined gravimetrically using soxhlet method (Mod Bauminger 1974).

Determination of the rate of bacteriological spoilage

An isolates of bacteria that decay *Lycopersicon lycopersicum* was obtained from already decayed *Lycopersicon lycopersicum* in a store that sells *tomatoes*. This was done by streaking the decaying *L. lycopersicum* on a prepared nutrient agar plate and incubated at 37^{0}C for 24 hours. After which the organisms were gram stained to confirm bacteria contamination. Small quantities from the colonies were put into test tubes containing 9ml distilled water and serial dilutions were made to establish the inoculation dose. The specific dilution used for the inoculation was plated using pour plate method and this gave 60 Cfu/ml as the inoculation load. 1ml of the dilution was used to inoculate each pre-weighed (almost the same weight) samples of *L. lycopersicum* at the various stages of ripening with a sterile syringe. The cultured *Lycopersicon lycopersicum* were kept at room temperature in the laboratory for 24 hours after which the samples were sliced using sterile blade under aseptic condition. Serial dilutions of each sample groups were made and total plate count were carried out by pour plate method using 1 ml of 10 dilutions of each sample solutions.

Dilutions were plated and incubated at 37^{0}C for 24 hours after which the plates were read.

RESULTS

The results of the moisture, protein, glucose fat and bacterial count for the three varieties, which are var. pyriforme, var. validum and var. commune respectively are shown below.

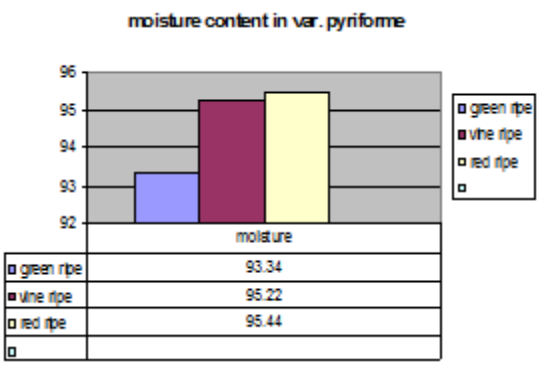
Table 1, 2, 3, show the results of the nutrients (Moisture, protein, glucose and fat) content of tomato at different ripening stages. The result of the moisture content shows gradual increase along the stages of ripening. However, there is no significant difference between the three varieties. The protein content of the three varieties shows no significant difference. Though there was an increase in the protein content as the fruit transited along the stages of ripening. The glucose composition also showed no significance different between the three varieties. However, there was a gradual decrease as the fruit ripens. The fat content of the three tomato varieties also show a gradual increase along the stages of ripening.

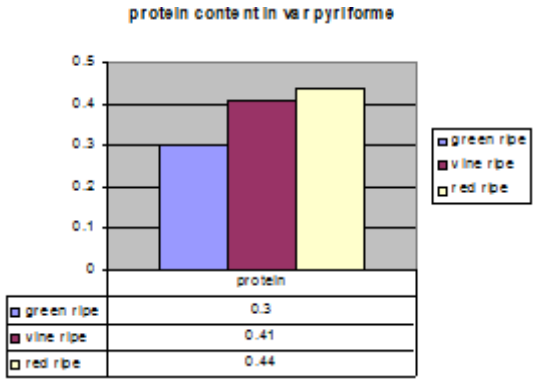
Three readings were taken for each value of the moisture, protein, glucose and the fat contents from which average and mean deviation were calculated.

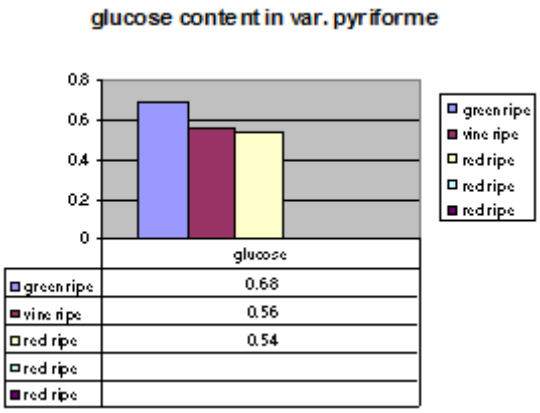
Table 1: Nutrient content in Var. Pyriforme at different ripening stages

Nutrient	Green ripe	Vine ripe	Red ripe
Moisture	93.34 ± 0.19	95.22 ± 0.30	95.44 ± 0.31
Protein	0.30 ± 0.01	0.41 ± 0.01	0.44 ± 0.02
Glucose	0.68 ± 0.00	0.56 ± 0.00	0.54 ± 0.00
Fat	0.17 ± 0.00	0.20 ± 0.00	0.21 ± 0.01

Values are expressed as mean ± SEM (n=5) samples per ripening stage of tomatoes







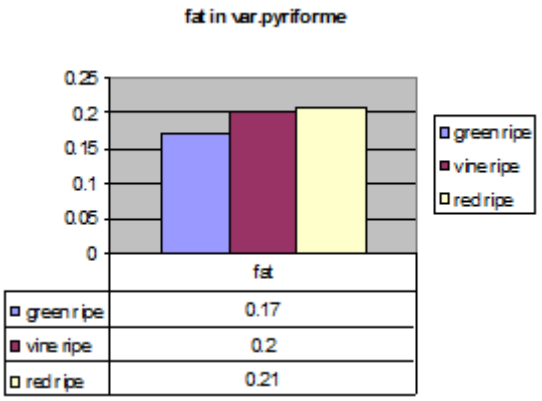


Table 4, shows the bacterial count for the three varieties. The result shows high count in the red ripe stage followed by vine ripe and green ripe has the lower total bacterial count in all the varieties.

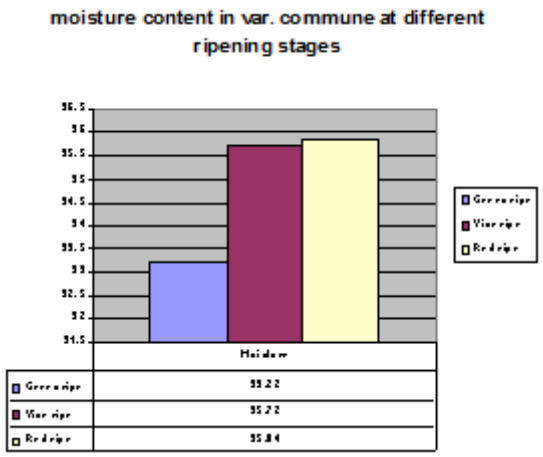
DISCUSSION

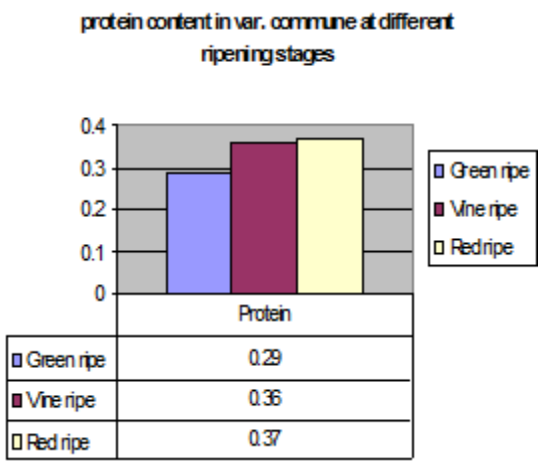
Fruits constitute some of the major food items in the tropics and happened to be the main

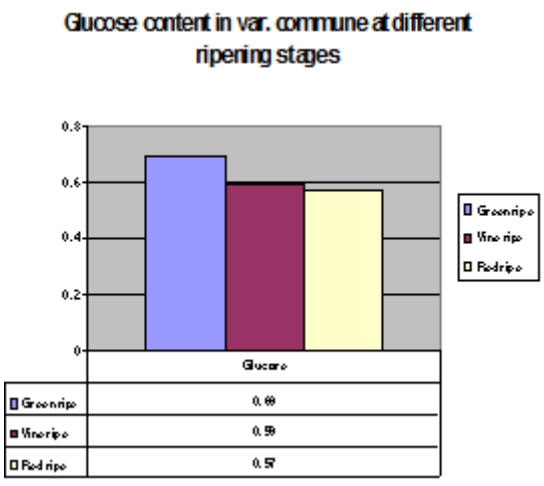
Table 2: Nutrient content in Var. commune at different ripening stages

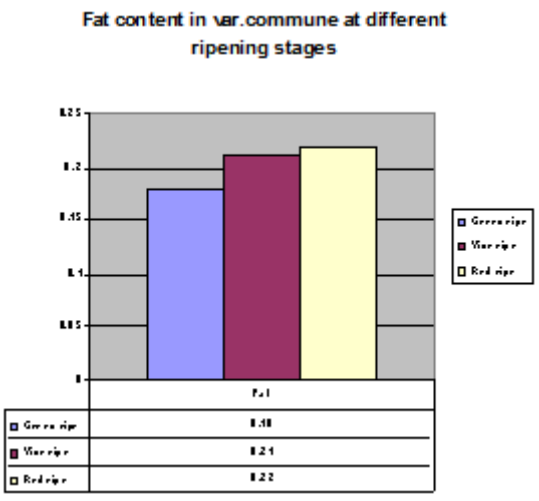
Nutrient	Green ripe	Vine ripe	Red ripe
Moisture	93.22 + 0.27	95.72 + 0.17	95.84 + 0.12
Protein	0.29 + 0.0.01	0.36 + 0.02	0.37 + 0.01
Glucose	0.69 + 0.00	0.59 + 0.00	0.57 + 0.00
Fat	0.18 + 0.00	0.21 + 0.00	0.22 + 0.00

Values are expressed as mean ± SEM (n=5) samples per ripening stage of tomatoes









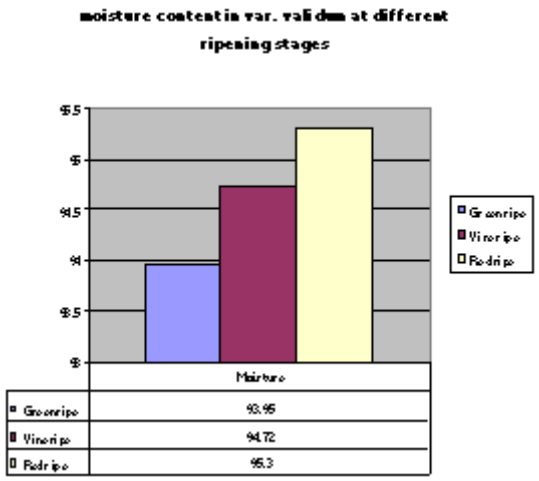
source of essential vitamins and minerals (Fox and Cameroon, 1978). Tomato, among common fruits grown provides substantial quantity of nutrient intake in the diet (Tindall, 1983). It might be possible that different varieties at different ripening stages might give different nutrient contents. For this reasons, three varieties grown in loamy soil were subject to some biochemical analysis.

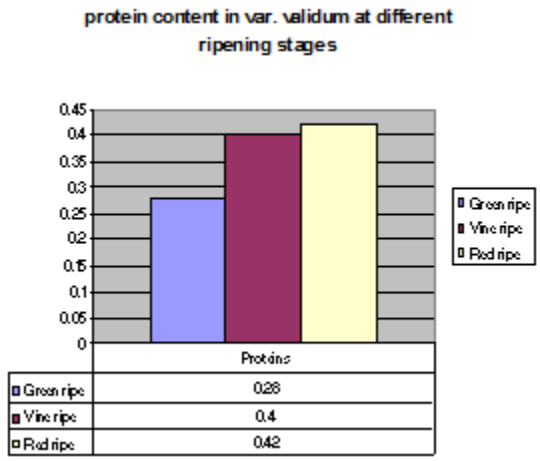
The result of this study revealed that at different stages of ripening, moisture content in the three varieties was not significantly ($P>0.05$) different. The percentage moisture content reflects the percentage dry matter (Emery and Munger, 1970)

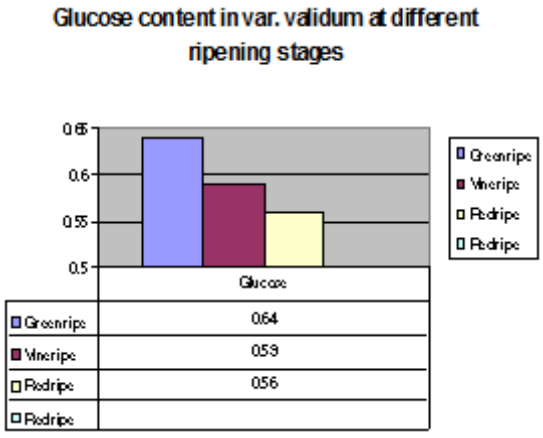
Table 3: Nutrient content in Var. validum at different ripening stages

Nutrient	Green ripe	Vine ripe	Red ripe
Moisture	93.95 + 0.26	94.72 + 0.17	95.30 + 0.18
Proteins	0.28 + 0.01	0.40 + 0.02	0.42 + 0.02
Glucose	0.64 + 0.00	0.59 + 0.00	0.56 + 0.00
Fat	0.19 + 0.00	0.21 + 0.00	0.22 + 0.01

Values are expressed as mean ± SEM (n=5) samples per ripening stage of tomatoes







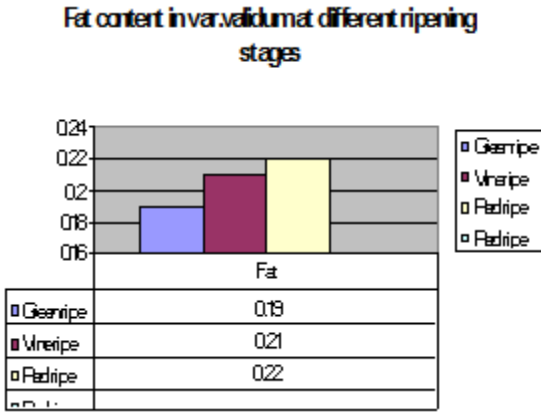


Table 4. Total bacterial count of three varieties of tomatoes indicating nutrient-ripening stage effect

Ripening stage	Total Bacterial count (Cfu/100ml)		
	var. pyriforme	var. commune	var. validum
Green Ripe	8×10^8	7×10^8	8×10^8
	9×10^8	8×10^8	9×10^8
Vine Ripe	1.2×10^9	1.4×10^8	1.4×10^9
	1.4×10^9	1.3×10^8	1.5×10^9
Red Riped	2.2×10^9	2.3×10^9	2.3×10^9
	2.0×10^9	2.1×10^9	2.3×10^9

There was a significant ($p<0.05$) increase in total protein as the tomato fruit transited from one stage of ripening to another in all the three varieties. The increase might be explained thus, during ripening many mRNA are transcribed in the nucleus and transported to the cytoplasm for the synthesis of enzymes required for the ripening process, solubulization of peptic substance, degradation of starch and inter-conversion of sugar, synthesis of pigment etc. (Gierson and Kedar, 1986)

The result of the glucose estimation showed a significant ($p<0.05$) decrease in the amount from one ripening stage to the others in the three varieties. This decrease may be due to the synthesis biochemical reactions that occur at various stages in which glucose is used in the production of energy and non-structural protein (Will et.al 1989). The glucose content between the three varieties also showed no significant ($p>0.05$) variation.

There is a significant ($p<0.05$) increase in the fat content along the stages of ripening also with no significant ($p>0.05$) difference between the three varieties.

The total plate count indicates higher number in the red ripe stage in all the varieties, followed by vine ripe with green ripe having the lowest plate count. The differences in bacterial count indicate significant nutrient-ripening stage effect on storage and rate of spoilage of the vegetable. This difference in the rate of spoilage could be as a result of the differences in the composition of readily fermentable nutrients. This composition has an influence on the subsisting abilities of the spoiling bacterial agent. The firmness of the fruits might have contributed also, which changes from toughness to softness along the stages of ripening (Kans, 1949).

Recommendation

- This work has helped to establish a relationship between nutrients and ripening stages, which can be recommended to factories that process tomato with a specific interest in a particular nutrient. For instance fat and or protein requirement should use red ripe.
- Processing of red ripe tomato also requires high bacterial contamination control because of their susceptibility to bacterial spoiling agents.

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