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TOMATO PRODUCTION IN POWDER: A TOMATO CONSERVATION TECHNOLOGY TO SUPPORT THE COMMUNITIES AND METHODOLOGICAL PROPOSAL FOR CHEMISTRY CONTEXTUALIZED EDUCATION

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ABSTRACT: The tomato is a very produced food in Mozambique in particular in the District of Gorongosa. This product although it is often used in the confession of food, have little time left paradoxically rich in vitamin C, lycopene and also contains the β -carotene. Both belong to the family of carotenoids, terpenoids (pro-vitamin A). In operation of the human body are given rise to a series of chemical reactions where mostly formed free radicals (unstable and reactive) that react rapidly with various compounds and cellular targets, in many of these reactions can damage DNA, proteins lipids, carbohydrates, etc. causing various diseases that affect humans. The tomato has β -carotene and lycopene are carotenoids act as an antioxidant because of their conjugated double bonds susceptible to oxidation under the action of light or oxygen. The study was dedicated to the determination of carotenoids (lycopene and β -carotene) in tomato powder and fresh. The motivation for the study came from research on production of dried tomato funded by the Ministry of Science and Technology powder through the National Research Fund, categorized as a project of Innovation and Technology Transfer, held in 2013, instructing associations Báruè Districts and communities Gorongosa District through a team of teachers, students and accompanied by representatives of the Government and institutions. Because tomatoes have little shelf life and important game against vitamins and natural antioxidants, after successfully obtaining the tomato powder, to be a viable and recommended alternative for communities urged the need to do laboratory analysis of carotenoids in it existing and comparing with the fresh tomato. Analyses for determination of carotenoids were made in different laboratories (UP- Beira and Chimoio – UCM), but all were with the help of the spectrophotometer, differed in laboratory reagents and other materials. As other nutrients such as sugar and vitamin C could somehow influence the activity of the microorganisms etc. was also performed analyzing sugar levels in fresh tomato based refractometer. The survey results show that the extraction of carotenoids is made with use of organic solvents and subsequent identification using various methods such as high performance liquid chromatography (HPLC), calorimeter, thin layer chromatography (TLC) and spectrophotometry. It is also noted that processing of carotenoids caused an increase and decrease in sugar and vitamin C (ascorbic acid). It follows that in 100kg of fresh tomatoes are obtained 6kg of tomato powder and that levels of carotenoids such as lycopene both β-carotene in tomato powder are larger than fresh tomatoes according to the processing mode used. An open set of chemistry content such as mass conservation law, stoichiometry, concept of atom, molecule, dehydration, vaporization, laboratories and experimental lessons etc., May be taught or understood very easily with the aid to processing phase, creating conditions for the long lasting grasping, consequent contextualized meaning as well as effective and affective grasping.

Keywords: Tomato powder, fresh tomato, carotenoids, conservation technology, chemistry contextualized education

INTRODUCTION

Tomato production takes place everywhere in the world, but his short life time, difficulty, lack of handling conditions and conservation technologies especially in producing communities, where most of them have a low

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family income, Creates the need for search, create, innovate or proposed conservation technologies of this product in accordance with the conditions of each community as a target group.

According to the conditions of the rural communities of the districts of the central area and the whole country in General regarding the lack of cold storage system, associated with this is the resistance of microorganisms at low temperatures compared to high, the presence of water to the metabolism of these, etc., the transformation of fresh tomatoes in tomato powder can be the best alternative for the conservation of tomato.

The tomato is a product of easy access, and in its transformation from fresh to powder, several phenomena as physical, chemical, nutritional aspects can happen. All these phenomena, especially the nutritional aspects may interfere negatively or positively on human health.
Both the transformation of fresh tomato to powder as the changes of the nutrients can be extensively used not only in the transfer of processing technologies to support the community but also as methodologies for teaching various chemical contents of contextualized, effective and affective way.

The tomato is a fruit classified as a legume rich in carotenoids, including lycopene and β-carotene. These carotenoids are responsible for the color of tomatoes and at the same time are antioxidants that act on free radicals.

Free radicals often break unsaturated fatty acids, impairing the ability of the membrane to transport substances into and out of the cell. Free radicals also damage cellular proteins, altering their functions and DNA, disrupting all cells that have inherited this damaged DNA Zeraik and Yariwake (2007).

Lycopene is a carotenoid found primarily in tomatoes (Holden et al., 1999;. Rodriguez-Amaya et al, 2008), where their chemical structure (extended conjugated double bonds) give it a property to provide the red color of tomatoes and a large and important antioxidant properties, which is manifested by the ability to react with free radicals, especially singlet oxygen, formed from the irradiation of the oxygen by ultraviolet (UV) radiation (SCOTTI and Velasco, 2003; SIES and Stahl, 1996 cited Cefali, 2009, P. 19) responsible for lipid peroxidation of cell membranes, damaging them and causing diseases for the human organism.

The β-carotene is a carotenoid found in tomatoes also although in reduced quantities with respect to lycopene, has extended conjugated double bonds provides the yellow color to tomatoes, it has anti-oxidant capacity and pro-vitamin A.

In the high rate of unsaturation both of lycopene as the β-carotene, has been very instrumental in changing their levels in tomato processing, as factors such as heat, light and acids cause isomerization of trans carotenoid, which is the most stable form in nature, to the *cis* form, losing color and pro-vitamin activity.
Carotenoids are also susceptible to enzymatic or non-enzymatic oxidations that depend on the carotenoid structure, availability of oxygen, the presence of enzymes, metals, pro-oxidants and antioxidants, high temperature and exposure to light. (SCHROEDER & JOHNSON, 1995).

Taking as a basis the transfer of technology to communities, the importance of carotenoids and its easy change in processing, the focal point of the study was to determine the levels of carotenoids in tomato powder and fresh and in parallel there was relationship between data in this process all with chemistry teaching content, contextualizing teaching.

The study was conducted in three stages, with the first to the tomato processing that took place in interaction lines between science, technology and society which took place in the district of Gorongosa, place the tomato study origin and the second step was the determination of carotenoids in laboratory tests and the last step was chemistry teaching contents of study that can be taught based on practical examples of processing steps and analyzes the study of tomato.

Topic Study Rationale

The production of tomato powder was simply a curiosity that came from products of agro-processing work carried out in the districts, in a project that combined the GAPI, the first lady's office and the UCM-Faculty of Engineering.
The results of the first project of agro-processing with respect to product shelf life difference processed in relation to unprocessed, diversity processing and its use has led to attention in particular to the study and processing of tomatoes to be one of the main products of the kitchen and with much less life time.

Upon successful production arose concerns about components of tomato that could be changed, and various other aspects such as color, nutritional value, its mode of application, etc.

About fresh tomato that is dried and turned into powder, can be made a number of studies as the amendment of its nutrients are many (e.g. protein, fat, saturated fatty acid, monounsaturated and polyunsaturated, phosphorus, carbohydrates, vitamin A, ascorbic acid, etc.), or interference in the methods and processing conditions, studies of existing microorganisms and changes of the population caused by processing among others. For the study was not so widespread, we are dedicated in the determination of carotenoids in tomato because of its importance both in color and in the prevention of some diseases which are described in the work and later relate the different process steps with the teaching contents of chemical.
The choice of study of the tomato components was motivated by the project designed by the author who was tomato agro-processing "tomato powder" and which was funded by the Ministry of Science and Technology through the National Research Fund in the 4th call. Due to the impact of this project on fieldwork and its dissemination in social networks emerged proposals to continue with analysis of some tomato nutrients.

Since the processing following steps as the selection of tomato, washing, drying and finally grinding, all methods of a or otherwise interfere with the modification of the nutritional value of the tomato, it was found that it was important to study the nutrients that are most likely they could be changed and perhaps creating a huge gap of quantity in tomato powder and fresh.

By changing some nutrients, several products can be converted from food to poisonous products, others still nutritious not nutritious at other times certain changes may lead to dose modification consumption, especially when it is controlled diets for some reason.

Some Similar studies were published in Brazil and Greece but with full difference in processing mode, and in some cases, studies of carotenoid in dry tomato and not necessarily in powder and in case of tomato powder was used for processing machines grinding and drying of tomato and thermal conditions, and entirely different drying conditions.

The study is set in the following areas: chemical and enhancement of natural products, modern instrumental analytical methods, interaction science, technology and society and school chemistry lab.

Characterization and Placement Problem

The tomato is a food rich in vitamin C, lycopene and also contains the β-carotene. The two carotenoids (lycopene and β-carotene) belong to the family of the terpenoids that are pro-vitamin A.

The human body is considered reactor therefore its operation to give rise to a series of chemical reactions. In many of these reactions are formed free radicals (unstable and reactive) that react rapidly with various compounds and cellular targets, may in several of these reactions damaging DNA, proteins, lipids, carbohydrates, etc. causing various diseases that affect humans.

The tomato has β-carotene and lycopene are carotenoids which act as an antioxidant because of their conjugated double bonds susceptible to oxidation under influence of light and oxygen. According Zeraik and Yariwake (2008):

Antioxidants are substances capable of reacting with free radicals and neutralizing them, with such beneficial effects slowing the process of atherosclerosis, prevention of obstruction of arteries and reducing the process of cell death in various organs such as the brain, kidneys, lungs and skin.

Carotenoids are also absorbed in the intestine and transported in the blood associated with plasma lipoproteins. Blood play some important biological functions including the prevention of hypertension. The intake of β-carotene reduces the potential incidence of cancer and production of Vitamin A, while lycopene can be used for controlling diseases such as diabetes, anemia and production of vitamin A in addition to preventing malfunction of kidney function.

The β-carotene and lycopene have a high oxidation capacity which can alter the nutritional value of tomatoes from their collection, processing until ingestion. The production of tomato powder takes several steps, one of which is unusual to cool drying which is where various physical and chemical phenomena occur due to exposure to the sun and atmospheric air, high temperatures, etc. They alter the content of its components such as β-carotene and lycopene which in turn can interfere positively or negatively in the nutritional value of the tomato. For Della Lucia at al (2008):

"[...] It is very important to predict such changes especially in the case of loss and establish preventive measures and criteria that can be adopted to minimize the nutritional damage both at home, and in communities of food services."

As well as other risks that compromise the quality of food, the loss of nutritional value directly affect the health of consumers and is no less important than the others, although some of its consequences potentially be perceived in the medium and long term.
Carotenoids as colorants may show more or less depending on their exposure to sunlight, temperature, tomato grinding, dehydration, oxidation, among other things that the processing itself has the step and risks.
Associating the reasons and reality, especially the loss of tomato in a short lifetime, ensuring that turns them into powder would have longer life the fact that there are contents of educational programs that require manipulations, there were some issues:

- How to turn fresh tomato modes powder to support communities in the conservation of tomatoes?
- What is the level of carotenoids (lycopene and β-carotene) in tomato powder and fresh?
- What contents of chemistry can be taught during the process of tomato transformation?

Objectives

- Develop individual, collective and institutional capacity for increased creativity and solving specific problems of society;
- Systematize and transfer agricultural processing technologies for the local population, the province and the country;
- Help communities in the conservation of agricultural surpluses, reduction of post-harvest losses and increase the yield and quality of life;
- Creates space for interaction school-community where through transfer of knowledge and technologies to solve these specific problems.

MATERIALS AND METHODS

The study had as its primary basis of research, innovation and technology transfer through teaching. The starting point was the tomato processing mode, the likely changes of nutrients and causes. For purposes resorted to methods that are: literature review, experimental (laboratory tests) and education (imparting knowledge to students and local community).

Tomato processing work on the principles and connecting lines between science, technology and society. The fundamental principle that guided the work was research and innovation tomato processing techniques and subsequent transfer of the techniques / technologies to students and these in turn local communities.

The processing work team was composed by Professors, university students of food engineering course, representatives of the Government, an institution that supports communities (Gorongosa National Park) and grouped populations in villages of Canda and Vinho in Gorongosa District.

Students played a crucial role in the work since served as a vector of transmission of the University knowledge (represented by the author of the work and supervisor) to local communities, a true spirit of teaching based on the model of context "The Salters approach", where these in turn had the mission to spread the neighboring communities serving a responsible agent of the multiplier effect.

The process of transmission of knowledge was the result of study and training for students by the author of the work, followed by testing for the domain and consolidation of content and subsequent transmission of this that was held by teaching local communities under author tutoring and monitoring supervisor.

Laboratory tests were carried out in different laboratories due to the conditions and reagents. The β-carotene analysis was performed at the Laboratory of Pedagogical University – Beira Branch and, for lack of refractometer and not location quartz cuvettes or glass the sugar and lycopene level, were made in the laboratory of UCM-Chimoio.

Tomato Processing

Selection: was selected tomato with good quality considered, leaving the part of the semi-rotten tomatoes and unripe not to influence the level of drying, taste or even at the level of conservation and or putrefaction.

Figure 1. Greenhouse Ready

Washing; Court; Drying:

Figure 2. Cut and Dried Tomato.

Milling**:**

Figure 3. Tomato powder

Laboratory tests
Determination of β-carotene
Materials and reagents:

The materials and reagents used for extraction and determination of β-carotene in the tomato powder and fresh, were of good quality and recommended for this analysis, as shown in the table below:

Table 1. Materials and reagents for extraction and determination of levels of β-carotene

Materials	Reagents
Spectrophotometer UV-Vis (Cintra 20, GBC);	Fresh tomatoes;
Plastic cuvettes;	Tomato powder;
Bath;	- Petroleum ether;
Analytical balance;	- Dichloromethane;
Becquerel 100 to 500ml;	- Distilled water
Blender;	
100ml volumetric flask;	
pipettes;	
simple funnel;	
filter paper;	
Spatula;	
squirt.	

Methods of Analysis

There are different methods of analysis for determining different products. Methods vary according to various aspects (type apparatus, the nature of the reagents, composition of the sample, objectives of the analysis, etc.) As the method of extraction or isolation of substance to analyze also vary

For example, the extract of carotenoids under study can use among various methods, as the open column chromatography according to the study Abreu Braga (2012), with the adsorbent magnesium oxide (Art Lab) and hyflosupercel (Synth) (1: 2, w / w) to the extraction of lycopene.

Can be used the method chromatography in liquid phase to the lycopene extraction, Cefali the second study, with the reactant ethyl acetate, ethanol, methanol, acetonitrile, among others. Some studies used calorimetric as a method for determining the carotenoid in tomato-based instrument called a calorimeter. According to Gondim (2010)
Some studies have reported methods of extraction and purification of carotenoids from diverse backgrounds. Liu et al. (1998) reported the use of organic extraction solvents and subsequent quantification by high-performance liquid chromatography (HPLC) retinol and carotenoids present in human milk. Fleischamann et al. (2002) showed a partial purification and kinetic characterization of carotenoids extracted from the quince (Cydonia oblonga). These researchers conducted an exhaustive procedure involving centrifugation, acetone precipitation, ultrafiltration, isoelectric focusing and polyacrylamide gel electrophoresis.

In general various experiments and studies as (CARDONA, 2006) (SACAMA, 2012), (RODRIGUEZ & AMAYA, 1999, p. 675), (Zeraik And YARIWAKE, 2008), OLIVEIRA, 2010), (Cefali, 2009), among others converge on the use of acetone, hexane, ethanol and distilled water for the extraction of lycopene and using petroleum ether, dichloromethane and distilled water for β-carotene extraction.

Therefore, the extraction of carotenoids for quantification can be performed by chromatography or by simply capturing reagents (complex-forming) of these. Due to the absorption capacity of visible light that carotenoids possess its main methods are calorimetric (calorimeter) and spectrophotometry (spectrophotometer).

We use the analysis method proposed by the League of California Food Processors that is fast spectrophotometer method for lycopene analysis. Note that this method is recommended by the Department of Food Science and Technology-Davis (SACAMA, 2013).

For extraction of β-carotene was used as the reagent petroleum ether, dichloromethane and distilled water as lycopene was possible with hexane, acetone, ethanol and distilled water and finally a sequence described in each step.

Reagent Preparation for extraction and determination of β-carotene

The extraction of β-carotene in tomato is made with petroleum ether and dichloromethane feature where 80 grams of tomato are to 100,0ml oil added phased ether and then dichloromethane in the proportion of 0.2g of extract - 1 liter of dichloromethane. After homogenization, the solution was placed in 3 trials for analysis by UV-Vis spectrophotometer at 453nm.

Determination of Lycopene
Materials and reagents:
Materials and reagents used to extract and determine the level of lycopene in tomato powder and fresh quality and were recommended for this analysis, as shown in the following table:

Table 2. Materials and reagents for the extraction and determination of the levels of lycopene

Materials	Reagents
1. Spectrophotometer UV-Vis (Zuzi);	Fresh tomatoes;
2. Glass cuvettes;	Tomato powder;
3. Analytical balance;	- Hexane;
4. Becquerel 500ml;	- Acetone;
5. 100ml volumetric flask;	- Ethanol;
6. Pipettes;	- Distilled water
7. Simple Funnel;	
8. Spatula;	
9. Squirt;	
10. Filter paper;	
11. Clock.	

Reagent Preparation for extraction and analysis of lycopene

The extraction of lycopene in tomato is made using hexane, ethanol and acetone in a ratio of 2: 1: 1. 0.3 grams of tomato are 12 ml of hexane, 6 ml of ethanol and 6 ml of acetone.

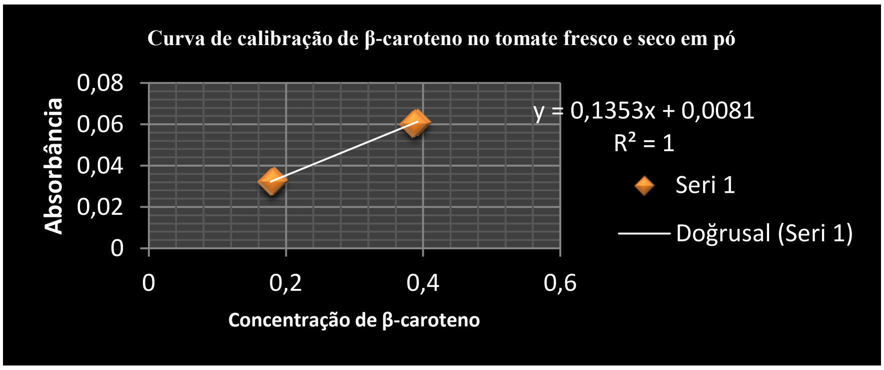
RESULT AND FINDING

β-carotene levels

The mean absorbance of β-carotene from the spectrophotometer (453nm) in fresh tomato (0.0326 Abs), and dried tomato powder (0.0607 Abs) we found a difference of almost double.
After the analysis in 3 trials by UV-Vis spectrophotometer at 453 nm yielded the following tabulated results:
Table 3. Analysis of Results of β-carotene

Spectrophotometer UV-Vis 453 nm			
Fresh tomato		Sun Dried tomato	
Absorbance (X) = Concentration (X mg / L)		Absorbance (X) = Concentration (X mg / L)	
0,0323 = 0,178	Average = 0,0326 = 0,181	0,0602 = 0, 385	Average = 0,0607 = 0,388
0,0325 = 0,180		0,0608 = 0,389	
0,0329 = 0,183		0,0612 = 0,392	

Using the line equation (Y = 0,1353x + 0.0081), we have:
Fresh tomatoes (Y = abs) then: 0.0326 = 0,1353x + 0.0081; x = 0,181mg / L
Tomato powder (Y = abs) then: 0.0607 = 0,1353x + 0.0081; x = 0,388mg / L



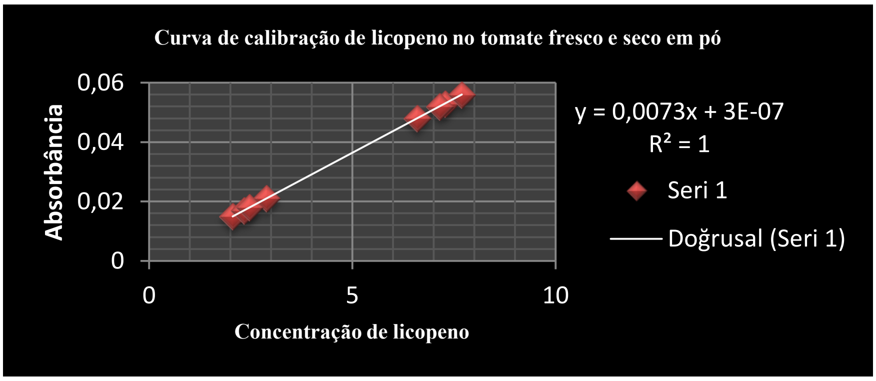
Lycopene levels

The mean absorbance of Lycopene from spectrophotometer (503nm) in fresh tomato (0.018 Abs) and Dried Tomato (0.052 Abs), the difference of the values are close to three times, as shown in the following table.

Table 4. Lycopene analysis results

Spectrophotometer UV-Vis 503 nm			
Fresh tomato		**Sun Dried tomato**	
Absorbance (X) = Concentration (X mg / L)		Absorbance (X) = Concentration (X mg / L)	
0,015 = 2,061		0,048 = 6,595	
0,017 = 2,336	Average = 0,018 = 2,473	0,053 = 7,282	Average = 0,052 = 7,145
0,021 = 2,885		0,056 = 7,694	

Using the line equation [**C (**mg/kg) = 137.4 x A503], we have:
Fresh tomatoes (0.018 Abs) then: C (mg / kg) 137.4 x = 0.018; C = 2,473
Tomato powder (0.052 Abs) then: C (mg / kg) 137.4 x = 0.052; C = 7,145



Discussion of results carotenoid levels (β-carotene and lycopene)

Any β-carotene and lycopene are in larger quantities in tomato powder compared to fresh. The temperature influences the change of carotenoids. Several studies as Bohm at all, (2003), SACAMA (2012), Souza (2002), etc., show that the temperature rise is directly proportional to the increase in carotenoid in tomatoes and inversely proportional Vitamin C.

"The fruit can be sun dried, artificial, or a combination of both methods. Sun drying affects quite the carotene and vitamin C content retention of vitamins in food artificially dehydrated is generally higher than that of dry food in the sun "(GAVA, 1984 apud SOUZA, 2002, p. 39)

The temperature influences the change of carotenoids. Studies such as Bohm at all, (2003), SACAMA (2012), Souza (2002), etc., show that the temperature rise is directly proportional to the increase in carotenoid in tomatoes and inversely proportional Vitamin C.

The dehydration of the food plays an important role on the microorganisms. According to Souza (2002, p. 39) "[...] the removal of water is a method of controlling microbial growth, since they require water to develop their metabolic activities". Minor microbial growth favors not decreasing the carotenoids by microbial action.

The transformation of fresh tomato dry was held in various t^o (t^o depended environment). According to the climatic conditions and the mountainous influences these allowed the retention of heat and subsequent diffraction by the plastic contained in the greenhouse at times thus increasing the thermal peak temperature of 76^o C.

The thermic process may also decrease the carotenóide, principally of β-carotene, according Cruz (2011, p. 38) "[...] the degradation of carotenóide is the result of isomerization of *trans* to *cis*-carotenóides and this isomerization is promote by thermic treatment which changes the color and biologic activity".

However, the processing way leads also to thermic phase, but the alternate conditions (heating at variable and moderated T^o, refreshment at shadow exposition), not allowing the isomerization great quantities of carotenóides, by the contrary, they decrease them.

The observed decreasing of the carotenóides in this analysis is linked to their contact surface due to its great standard cells liberation.

(CRUZ, 2011, p. 39) "The thermic processing breaks cells walls allowing the extraction of lycopene of chloroplasts" and this liberation grows as the heating increases depending on the heating duration too. (HADLY et al., 2002 apud CRUZ, 2011, p. 39).

Having greater amount of tomato carotenoids, especially β-carotene, the greater the production of vitamin A, since this is resulting from breakage and subsequent oxidation of β-carotene molecule by the action of light, heat or oxygen.

The great quantity of lycopene in dry tomato in relation to fresh tomato is the major gain of this type of processing, because it increases the possibility of the use of this anti-oxidant which is important on degenerative diseases such as breast cancer, prostate, lung, skin cancer, and so forth.
The tomato has a smaller amount of β-carotene (responsible for the yellow color) with respect to lycopene (responsible for the red color).

In many of the cases, the tomato processing increases the quantity of carotenoids and this increase may vary depending on the type of processing and external conditions.

CONCLUSIONS

For carotenoid extraction, organic solvents are used and the main and used in the study acetone, hexane, ethanol and distilled water for the extraction of lycopene and using petroleum ether, dichloromethane and distilled water for β-carotene extraction;

For determination of the carotenoids may be used various methods such as high-performance liquid chromatography (HPLC), calorimetry, thin layer chromatography (TLC), spectrophotometry, etc. We analyzed based on spectrophotometry;

Tomato in powder may be the best conservation way for the community;
An open set of chemistry content such as mass conservation law, stoichiometry, concept of atom, molecule, dehydration, vaporization, laboratories and experimental lessons etc.,
May be taught or understood very easily with the aid to processing phase, creating conditions for the long lasting grasping, consequent contextualized meaning as well as effective and affective grasping.

At last it has been understood that the levels of carotenoids either lycopene or β-carotene on tomato in powder are more than in fresh tomato taking in account the processing way used.

Limitations

The presenter could not search about processing and finding of carotenóides of unique specie of tomatoes.

Challenge

Convince people to transform tomatoes from fresh to powder (because from 100kg of fresh we will get only 6kg of powder tomatoes)

Recommendations

To researchers:
It is recommended to search:
Several ways of tomato processing and finding its nutrients;
Other ways of tomato conservation and publish it to the population taking in account the specific life conditions of the target population.

To the public in general

It is recommended that: They should transform the fresh tomato to powder tomato, as a way of taking advantage of this product in difficult seasons gaining simultaneously improving health by increasing carotenoids which are antioxidants with great heeling advantage.

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