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Research Article

Model of Food Rations Rich in Lycopene to Include Their Consumption in the Usual Diet

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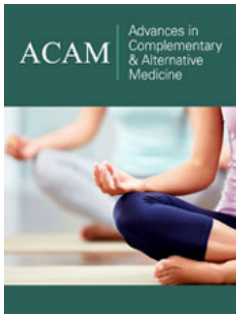

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Abstract

Lycopene is a carotenoid that has been shown to have antioxidant and protective effect for health. Numerous studies prove that it reduces the risk of cardiovascular diseases, osteoporosis and some types of cancer. The difficulties in recommending there are: that there is a great variability in the reported amounts of the different source foods, the different units of measurement used and that a Recommended Daily Intake (RDI) has not been established, so the objective of this work was to establish a model with rations of foods rich in lycopene in home measures to include there in the usual diet. The carotenoid compounds present in the source food samples were extracted. Carotenoids were separated and purified by thin layer chromatography using silica gel and light petroleum ether plates. By means of UV-visible spectrophotometry, the concentrations of lycopene contained in the carotenoids were determined, based on the spectrum of the lycopene standard and the amount of lycopene in 100gr was determined of food. Fresh and industrialized foods of specific commercial brand were used, finding greater lycopene content in the industrialized ones: tomato juice, ketchup sauce and tomato puree. The amounts were determined by ration, in homemade measures and trademark for easy inclusion in the usual diet. It is proposed to consume 50mg of lycopene per day to obtain its protective effects and include two examples of menu that integrate the rations of foods rich in lycopene.

Keywords: Lycopene; Antioxidants; Carotenoids; Tomato; Food rations; Cardiovascular diseases; Cancer prevention; Tomato juice; Ketchup sauce; Tomato puree

Abbreviations: ERO: Reactive Oxygen Species; 2(Nrf2): Erythroid Nuclear Factor; PSA: Prostate Specific Antigen; MDA: Malondialdehyde; SCI: Spinal Cord Injuries; IDR: Recommended Daily Intake; ADI: Allowable Daily Intake; NTOE: Natural Tomato Oleoresin Extract; FIQ: Faculty of Chemical Engineering; UADY: Autonomous University of Yucatán; NOM: Official Mexican Standard; Profeco: Federal Consumer Attorney's Office; UV-vis: Ultraviolet in visible Ranges; SAME: Mexican Equivalent Food System; EFSA: European Food Safety Authority; GR: Reactive Grade; ORAC: Oxygen Radical Absorbance Capacity

Introduction

Antioxidants are substances that have shown that addition to their nutritional effects, produced benefits in one or more body functions that increase their health and prevent or reduce the risk of chronic diseases, and involved in the elimination of active species oxygen (free radicals), formed by human metabolism; They also participate in other functions such as the regulation of genetic function, hormonal and immune modulation, in carcinogenic metabolism and in the metabolic pathway through the induction of enzymes [1-3]. Among the non-enzymatic antioxidants from food, the most recognized are found in the vegetable kingdom, being provided by fruits and vegetables, with carotenoids and ascorbic acid standing out among the most potent. Carotenoids are natural pigments responsible for their color ranging from yellow to red. Although, more than 600 types have been differentiated, the most active in terms of their antioxidant function are beta carotene, alpha carotene, lutein and lycopene [4]. Lycopene is a plant pigment that has an aliphatic open chain chemical structure of forty carbon atoms with thirteen double bonds, of which eleven are conjugated, which gives it the quality of being very reactive against oxygen and free radicals. Its main food sources are tomatoes, watermelon, pink grapefruit, pink guava and papaya and in some processed products such as ketchup, mashed potatoes and tomato juice [5]. It is also found in high concentrations in human serum (21-43%), as well as in the kidney, liver, renal glands, testes,

ovaries and prostate, whose concentration depends on its ingestion through the source foods [3,6].

Antioxidants such as lycopene, have the ability to interact with EROs by mitigating the damage because in their molecular structures have extra electrons capable of yielding the free radical in order to complete the missing in its external orbit; The EROs upon receiving the electrons become stable and harmless molecules, with which the chain reaction stops and the molecules that result from losing their electron are neutralized. Oxidative stress is one of the most important factors in the generation of chronic diseases, so antioxidants play a key role in human health, particularly on the skin, eyes, cardiovascular diseases, liver diseases and in the prevention of diseases such as cancer of the prostate, bowel, stomach, colon and rectum in men and of the cervix, breast, stomach and ovary in women [7].

There are studies that have shown that lycopene intake is correlated with the reduction of risk of cancer, emphasizing its association with the consumption of tomato sauce, raw tomato and pizza sauce, which have properties that alter the production of xenobiotic, modulate and they control abnormal cell growth and induce intercellular communication that regulates the rapid and uncontrolled growth of cells [5,8-12]. In the case of prostate cancer, which is the most studied, Magbanua et al. [13], Suggest in their research that the intake of lycopene for 12 weeks, modulates signaling pathways in vivo as oxidative stress mediated by erythroid nuclear factor 2 (Nrf_2) in patients with low-risk prostate cancer. The consumption of lycopene decreases the risk of prostate cancer by 2%, with the intake of foods that provide 0.2mg/day [14], while other authors recommend between 9-21mg/day to obtain that same effect [15]. Paur et al. [16] Conducted a study with 79 men with prostate cancer randomized to three different interventions: one with tomato products with 30mg of lycopene per day; the second with tomato products plus selenium, omega-3 fatty acids, soy isoflavones and grape or pomegranate juices, green or black tea and the third only to control the diet for 3 weeks. The objective was to test if the intervention with foods rich in lycopene could reduce the prostate-specific antigen (PSA) levels in this type of patients of all risk categories. The results showed that in post-hoc analyzes in patients with intermediate risk (n=41) based on tumor classification and Gleason score after surgery, that the median PSA decreased significantly in the lycopene-rich intervention group compared to controls (-2.9% and +6.5% P=0.016) after three weeks of treatment [16]. However, there are other studies that do not show their effects significantly, such as those performed with subjects diagnosed with prostate cancer and benign prostatic hyperplasia, where it was found that the intake of 30mg of lycopene for 21 days does not produce Significant modifications in the biomarker of oxidative damage to DNA 8-oxo-7,8-dihydro-2'-deoxyguanosine (8-oxo-dG) in prostate tissue or in plasma levels of malondialdehyde (MDA) as an indicator of oxidative stress systemic [17]. Other works support this approach such as that of Kirsh et al. [18], Stram et al. [19], Waliszewski et al. [3], Graff et al. [12] and Lane et al. [20], Where insufficient evidence was found that lycopene protects against this type of cancer [3,18-20].

Cicero & Colletti [7], they affirm, that the irrational or excessive use of this antioxidant, coming from the diet or from supplements, can influence not to find conclusive results, so it is necessary to prove it alone and evaluate its safety in long term clinical trials with a large sample and heterogeneous. On the other hand, Antwi et al. [21]. Associate this problem with the combination of patients with aggressive and nonaggressive cancer. The role of lycopene in other diseases such as osteoporosis is being studied, through tissue culture with osteoclasts and osteoblasts incubated in different concentrations of lycopene, where osteoblast activation and a reduction in decalcification have been shown, as well as in the Resistance restoration and bone micro architecture [22]. In spinal cord injuries (SCI), treatment with lycopene (5,10 and 20mg/kg) in rats has shown significant improvement in oxidative damage produced by SCI (in T10), reversing mitochondrial dysfunction and cellular apoptosis, and significantly improving the motor alterations in the hind limb produced by the lesion, which represents neuroprotective effects [23]. Göncü et al. [24], Found that lycopene can suppress inflammation and oxidative stress in uveitis induced by endotoxin in rats, using 10mg/Kg of weight for three consecutive days, a situation that requires further studies. Yamamoto et al. [25], In a study conducted over 12 weeks with 44 men suffering from infertility (low concentration and sperm motility), found an increase in plasma lycopene levels and statistically significant increase in sperm motility at 6 and 12 weeks in the group treated with 1 can of tomato juice (30mg of lycopene) compared to the control group and the one that consumed antioxidants [25].

Epidemiological evidence states that there is an association between lycopene consumption and lower risk of cardiovascular diseases, since it protects critical biomolecules such as lipids and low-density lipoproteins (LDL), preventing them from oxidizing and causing damage to the cell membrane [26-28]. In a meta-analysis by Thies et al. [29], The findings indicate that lycopene exerts cardiovascular protection modulating the functionality of high-density lipoproteins (HDL) towards an antiatherogenic phenotype; In addition, studies in vitro indicate that lycopene could also modulate T lymphocyte activity and inhibit atherogenic processes. On the other hand, Cheng et al. [30], Reviewed evidence of intervention publications on the effect of consumption of tomato and lycopene products on markers of cardiovascular function taken from three databases (Medline, Web of Science and Scopus) until 2016; It was found that the increase of its intake has positive effects on blood lipids (LDL), blood pressure (systolic) and endothelial function (Interleukin IL-6).

Although there is controversy in the results of the different studies in vivo and in vitro due to several factors such as the target population (cells, animals, only men, only women or both), the duration of interventions, mixtures, dose and the food used, making it difficult to compare the results, there is already sufficient evidence of the effect of lycopene on human health, its benefits in the prevention and treatment of diseases that are currently the leading causes of death in the world, so it would be important to promote its consumption in the usual diet using different preparations, taking advantage of it being found in foods commonly used in most

of the world gastronomy [31-33]. Therefore, the objective of the present study was to establish a model with the food rations rich in lycopene in homemade measures to facilitate their inclusion in the usual diet, for which an exhaustive review of the bibliographic sources was carried out, reaching the following findings:

a. The recommended daily intake (DRI) of lycopene has not been officially established by the committees of experts and international organizations, only the admissible daily intake (ADI) of 0.5mg/Kg of body weight/day including natural sources and dyes [28,34].

b. There is great variability in the amounts used for their consumption in the different studies, which represents a too broad range, between 3.7 to 60mg [35-40].

c. Some authors have made the determination of the lycopene content in their source foods, but most have been expressed in milligram ranges per gram of the wet sample, which does not allow to calculate the rations [3].

d. Other authors such as Vitale et al. [5], & Martín et al. [41], present their results in milligrams per gram of food, in portions and their corresponding lycopene contribution per portion, but do not specify the commercial brand of the processed products or the type of raw foods [5,41].

When it comes to fresh foods, there are factors such as: type, variety, degree of maturity, seasonal conditions, among others, that influence their lycopene content. When it comes to processed products (sauces, purées, juice, preserves) the commercial brand is important, since its nutritional characteristics are specified there. The recommendations of consumption become more complicated when not having the specifications of the product [35]. Regarding its toxicity, most studies with lycopene and other carotenes have been conducted in rodents, which absorb them with less efficiency than humans. Matulka et al. [42] Used natural tomato oleoresin extract (NTOE) in rats and reported that 50% of the lethal dose derived from acute oral toxicity was greater than 5,000mg/kg of body weight, which did not occur when 2,000mg/Kg of body weight was used. McClain et al. [43], Measured the toxicity of NTOE also in rats and found low levels of acute toxicity [43]. In order to establish the food rations rich in lycopene, it was first necessary to quantify this carotenoid in its source foods; for which, the pertinent steps were carried out in the Faculty of Chemical Engineering (FIQ) of the Autonomous University of Yucatan (UADY) with the purpose of having the Materials and Instrumentation Laboratory and the technical and scientific support, using the method of extraction with solvents in stages according to the technique used by Cardona et al. [44] and Fernández el al. [45] for the development of this work. Afterwards, the reagents and the necessary material were purchased, together with the existing equipment in the Materials and Instrumentation Laboratory of FIQ, are presented in Table 1.

Table 1: Reagents, material and equipment used in the extraction of lycopene.

Reagents	Materials	Equipment
Commercial grade ethyl acetate	Dividing 250ml Spatula	Vacuum pump BÜCHI labortechnik AG V-700
Acetone reactive grade (G.R.)	Mangers Make 250ml balloon	Development chamber for space TANK 34104-00
Sodium chloride 10%	Make Erlenmeyer 250ml	capacity 5 dishes
Light oil ether	10ml volumetric flask	UV-Vis spectrophotometer, THERMO SCIENTIFIC type evolution 300LC
Hexane reactive grade (G.R.)	25ml volumetric flask Micro spatula	Stress Lab-line IMPERIAL-V
Lycopene Sigma-Aldrich L9879-10 MG	Mortar with pistil Filter paper	UVGL-25 model lamp, uv-254/366nm, 115 volts
Sodium sulfate anhydrous	Pipe three-way Probeta of 25ml 250ml TPTT cup 500 ml TPTT cup Vine 1.5ml	20x20 Silicagel Plates 60GF254 - Rotavapor BÜCHI Switzerland R-21

Subsequently, the purchase of the source foods was made, which they were identified by their organoleptic and physical characteristics following the guidelines of the Official Mexican Standard NOM-251-SSA1-2009. Hygiene Practices for the Process of Food, Beverages or Food Supplements, of the Ministry of Health of the United Mexican States, specifically subsections 5.6. Control of raw materials and 5.7. Packaging control [46].

In fresh foods, maturity, integrity of the pieces and quality were considered. The integrity of the packages, the expiration date and the commercial brand were considered in the processed foods considering the recommendations of a study carried out by the Federal Consumer Protection Agency (Profeco) carried out in 2010 to 18 products denominated in the market as “mashed potatoes”. tomato”; the content of tomato solids, the salt content, the addition

of dyes, thickeners and preservatives and sanitary quality were verified in each product according to the Official Mexican Standard NMX-F-033-1982. Food for humans. Packaged tomato puree. The Profeco considered the commercial brand La Costeña® as the best tomato puree that although it is seasoned, meets the content of tomato solids, contains little salt, does not contain preservatives, thickeners or dyes and its price is accessible ($1.80 mexican pesos per 100g.) [47,48]. The analysis of 12 brands of ketchup sauce and 9 ketchup-type tomato sauce was also carried out with a total of 1,290 tests base d on the Mexican Official Standard NMX-F-346-S-1980 Cátsup Tomato Sauce, finding that the three brands of ketchup sauce that contain the highest amount of tomato solids: HEINZ® (11.1%), Santiveri® (10.4%) and La Costeña® (9.4%) [49].

Material and Method

Selection of lycopene source foods

Considering the above results, the fresh foods that were analyzed were: tomato saladette (Solanum lycopersicum "Rome"), pink grapefruit (Citrus×paradisi Macfad) papaya maradol (Carica papaya), yellow guava (Psidium guajava) and red watermelon (Citrullus lanatus). The processed foods were: COSTEÑA® brand tomato puree, COSTEÑA® brand ketchup sauce, JUMEX® brand tomato juice, all of them were purchased at the supermarket located in the city of Mérida, Yucatán, México. The fresh and processed foods were sanitized with soap and water and then rinsed with a water jet and then processed using the reagents, material and equipment required.

Preparation of the sample

1. Samples of 5g of each food were taken and they were crushed in a mortar with 25ml of reactive grade acetone; they were treated repeatedly until homogeneous colorless extracts were obtained.

2. These ketone extracts were filtered with a BÜCNER funnel under vacuum using filter paper of number 5 and evaporated with vacuum BÜCHI Switzerland R-215 steam under vacuum until drying of the homogenate to dilute it in 25ml of ethyl acetate. commercial grade.

3. Subsequently, they were transferred in a separatory funnel with 25ml of sodium chloride (NaCl) at 10% and mixed by shaking carefully.

4. The aqueous and ethereal phase was separated, by washing successively, until the aqueous phase became colorless.

5. Then, the ether phase was dehydrated using anhydrous sodium sulfate as desiccant and it was subjected to a solvent elimination process using a rotary evaporator coupled with a vacuum pump and a temperature lower than 40 °C during, 30 minutes; the finally dry sample was diluted in light petroleum ether in order to perform thin layer chromatography. All this procedure was performed under reduced light.

Extraction of lycopene

1. Through thin layer chromatography, carotenoid pigments were separated and purified; For this purpose, silica gel 60GF25 20x20 plates were used and light petroleum ether was used as development solvent.

2. The carotenoid extract was placed in small proportions using the Pasteur pipette on the plates previously activated in the oven at 120 °C for one hour.

3. Later they were taken to the development chamber for 30 minutes, the plates were extracted, and dried to observe them under ultraviolet light.

4. We used 5mg of the lycopene standard to later collect the pigments of the samples together with the standard in question and proceed to its identification by UV-Vis spectrophotometry, THERMO SCIENTIFIC type evolution 300LC at a wavelength of 450nm.

Preparation of the lycopene standard: A stock solution of 500ppm was prepared by diluting 5mg of the lycopene standard in 10ml of hexane, for which the lycopene standard Sigma-AldrichL9879-10MG was used as standard; from this sample, different successive dilutions were prepared, in a confined nitrogen atmosphere, in a range of 1 to 4.5ppm and measured at a wavelength of 450nm by visible spectroscopy using a Spectronic 20.

Quantification of lycopene content: Once the thin layer chromatographic development was finished, the layer was scraped individually for each of the components, diluted with hexane and the absorbance was determined at the wavelength of maximum absorption, replaced in the equation of the straight line and the concentrations of lycopene were determined in the different samples, the identification of lycopene was based on the standard spectrum or lycopene standard that subsequently was quantified and expressed in milligrams per 100g of sample.

Result and Discussion

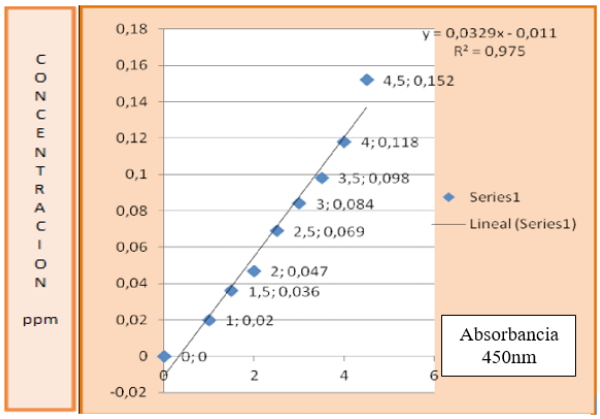

Figure 1: Calcopy curve of lycopene by spectrophotometry.

The concentration in parts per million (ppm) and the absorbance at 450 nm that corresponds to r2=0.975

Figure 1 shows the lycopene concentration of each of the food samples in ascending order from lowest to highest concentration, whose quantities in milligrams are shown below in Table 2. The highest content of lycopene was found in the industrialized foods derived from tomatoes: juice, ketchup and puree, while in fresh foods

it was observed that the lycopene content was lower, being similar between red watermelon, tomato saladette and papaya maradol and in smaller quantity in the yellow guava and the pink grapefruit. This coincides with Ordóñez et al. [50], Who states that during the operation of industrial sterilization of tomatoes the cellular release of lycopene occurs, which increases its bioavailability, which remains stable during storage. Other authors agree that the thermal treatment of cooking transforms theisomeric forms trans of lycopene into cis, which improves its absorption in the body, so that these processed foods can be considered functional [51-53].

Table 2: Contents of lycopene in the analyzed food samples

Foods	Contents of lycopene mg/100g
Tomato juice **	4.29
Ketchup sauce *	3.97
Tomato puree *	3.29
Watermelon red	2.75
Saladette tomato	2.11
Papaya maradol	2.03
Yellow guava	0.47
Grapefruit pink	0.37

The lycopene content of each of the samples was compared with the results reported by Waliszewski [3], finding differences between them as can be seen in Table 3. It can be seen that the foods where there are coincidences are grapefruit, watermelon and tomato juice and those with the greatest difference are papaya, tomato, ketchup and tomato puree. These differences may be due to several factors such as the variety or commercial type of food, the degree of maturity, which is very important in tomatoes, as well as seasonal conditions, given that higher lycopene content has been found in the summer crops than in winter ones [3]. The commercial brands of industrialized foods analyzed in the studies, which, as stated by Periago et al. [35], Are very few studies in the literature where these data are specified, which makes it difficult to establish unified guidelines for making consumption recommendations [35]. Using the results found, the rations of these foods were proposed to be included in the habitual diet, using the measures of the Mexican System of Equivalent Foods (SMAE) of Pérez et al. [54], Since its management is very simple since it uses commonly used measures. in the home kitchen: cup, glass, spoon, spoon, etc., and their equivalences in measurements of weight or volume (g or ml, respectively), as can be seen in Table 4; [54]. A mathematical operation of proportionality between three values and an unknown factor was used for the calculation since the quantities used are duly standardized in net weight. It is important to clarify that the measure and composition of ketchup sauce was taken from the Directory of Nutritional Food Composition, since it is not registered in the SMAE [55]. Martín et al. [41], Established food rations with the corresponding lycopene content in mg, the comparison with the rations established in the present study account for the great difference even when the rations in volume or grammage measurements are similar, for example: 1 glass of tomato juice has 25mg of lycopene in the study by Martín et al. [41], and 10.7mg in the present study; 1 spoonful of ketchup (15cc/ml) 2.7mg and 0.59mg respectively. These differences may be due to the fact that each study uses different dietary recommendations (food rations) and this is understandable, however, in terms of the amount of lycopene per example in the ration of ketchup (or ketchup) there is a difference of 2.11mg which is great if these rations are going to be used to recommend their consumption [41].

Table 3: Comparison of the results of the lycopene content in foods between two studies.

Food sample	Lycopene content in mg / 100g Present study	Lycopene content in mg/100g Wlaiszewki et al. [3]
Tomato Juice	4.29 ***	5.00-11.60
Ketchup sauce	3.97 **	9.90 - 13.44
Tomato puree	3.29 **	6.2
Red watermelon	2.75	2.3-7.2
Saladette tomato	2.11*	0.72-20
Papaya maradol	2.03+	0.11- 5.3
Yellow guava	0.47	-
Grapefruit pink	0.37	0.35-3.36household

***Jumex Brand, **La Costeña Brand, *Saladette Tomato, +Papaya Maradol

Table 4: Rations of foods rich in lycopene in measurements and grams.

Food	Ration		Amount of Lycopene in mg.
	Homemade measures	Grams	
Tomato Juice **	½cup	122	5.23
Red Watermelon	1cup	160	4.4
Papaya maradol	1cup	140	2.84
Saladette tomato	-	120	2.53
Tomato puree*	¼cup	63	2.07
Yellow Gayaba	3 pieces	135	0.63
Pink Grapefruit	1cup	150	0.6
Ketchup Sauce*+	1tablespoon	15	0.59

+Data taken from: Directory of Nutritional Food Composition at: **Jumex Brand, *La Costeña Brand

When counting on the food rations rich in lycopene, we proceeded to calculate a model with foods containing approximately 50mg to cover the therapeutic needs of 24 hours, as can be seen in Table 5, where the oxygen radical absorbance capacity (ORAC) values are included in the last column for each of the foods; these values show with certainty the relationship between the concentration of lycopene and the antioxidant activity of the foods that make up the model, which represents a total of 453.42mg EQ TROLOX [56]. It should be noted that the variety of fruits used, and the commercial brand of industrialized foods were included in order

to ensure the specified quantity and be able to make comparisons with subsequent studies using the same varieties and brands. Following the criteria established by EFSA (0.5mg/Kg of weight/day) as acceptable daily intake (ADI), a person weighing 60kg can safely consume 30mg of lycopene, but only 30% is absorbed, which would result in 9mg real consumption; Then, if you consume 50mg, as proposed in this study, you will be using 15mg and eliminating 35mg [57].

Table 5: Food rations that provide approximately 50mg of lycopene.

Food	Household Measures	Weight or Volume	Lycopene Content (mg)	Orac (mg eq Trolox)
Tomato juice**	2 cups	488ml	20.92	185.59
Red watermelon	2 cups	320g	8.8	78.06
Tomato puree*	1 cup	252g	8.28	73.45
Papaya maradol	2 cups	280g	5.68	50.39
Tomato saladette	2 pieces	240g	5.06	44.88
Ketchup Sauce*	3 tablespoons	45g	1.77	15.7
Pink Grapefruit	1 cup	150g	0.6	5.32
Total			51.11	453.42

It is important to consider that these recommendations of rations could be used by nutrition professionals in the planning of menus according to the requirements of each particular patient, increasing or decreasing the rations according to each case and also in the elaboration of different dishes, as well as being easily included by the patients themselves in their usual diet. Examples of the use of these rations in specific menus can be seen in Table 6. As the science of nutrition evolves new properties are discovered in foods that can and should be exploited since chronic diseases in the future are observed uncontrollable and represent millionaire costs to health institutions both in outpatient care, hospitalization costs and supply of medicines and that together with a healthy lifestyle can become a preventive and curative measure of these diseases.

Table 6: Examples of Use of food rations with 50mg of lycopene in the elaboration of menus.

Food Times	Example1	Example 2
Breakfast	1 cup tomato juice	1 cup of tomato juice
	1 cup chopped watermelon	1 cup of chopped papaya
	1 starred egg with ketchup	1 chicken sandwich mayonnaise, mustard, tomato and lettuce
	1 slice of whole wheat bread	
Colation	1 cup chopped papaya with 1 teaspoon of honey	1 cup of chopped watermelon
Food	Fresh salad of lettuce, tomato, carrot and avocado with olive oil dressing, garlic, lemon, salt and pepper	1 cup of vegetable soup1 entree
	½ cup of bolognese spaghetti	½ cup of Mexican rice portion of pork
	1 cup of watermelon, chopped	1 corn tortilla
	Water of grapefruit with sugar	1 cup of watermelon, chopped Water of grapefruit with sugar
Colation	1 cup of grapefruit segments	1 cup of chopped papaya
	1 cup of tomato juice	1 cup of tomato juice
Dinner	1 cup of chopped papaya	Fresh salad of lechug a, tomato
	2 Oaxacan cheese quesadillas with 1 tablespoon of half cream and tomato sauce	carrot and avocado with olive oil dressing, garlic, lemon, salt and pepper and strips of grilled chicken
	1 cup of light milk	1 glass of strawberry smoothie with sugar

Conclusion

The foods with the highest lycopene content were the industrialized ones: the juice, the ketchup sauce and the tomato puree, confirming the fact that the thermal treatment potentiates the bioavailability and the functional effect of lycopene, which is why, unlike other carotenoids, it is recommended to consume it through industrialized or cooked foods. A food model with 51.11mg

of lycopene per day is proposed, which provides 15mg absorbable (30%) including the variety of fruits used and the commercial brand of industrialized foods, in order to ensure the specified amount and thus make comparisons with subsequent studies. This study provides Mexican society with a simple way to include this antioxidant in the habitual diet, using fresh and processed foods common to our food culture, which are accessible in their acquisition and cost and reported in rations commonly used in home cooking, considering the brands and the variety.

This Table 6 presents the results of lycopene quantification in source foods. The first column presents the type of raw and processed foods specifying the type and brand respectively; in the second column the lycopene content in mg/100g is presented. The concentration in parts per million (ppm) and the absorbance at 450nm corresponding to ar_2=0.975. In this Table 6 we present the comparison of the results of the lycopene content in the source foods between the present study and that of Wlaiszewki et al. [3]. Nutraceutical properties of lycopene. The first column presents the type of raw and processed foods specifying the type and brand respectively; in the second column the lycopene content in mg/100g of the present study is presented and in the third one the lycopene content of the study by Wlaiszewki et al. [3]. This Table 5 shows the food rations that provide 51.11mg of lycopene per day. In the first column the type of food is presented, in the second the homemade measurements that can be cups spoons or glasses; in the third column the equivalences of the household measurements by weight (g) or volume (cc or ml) are presented, in the fourth column the lycopene content is presented per ration in mg and in the last column shows the ORAC value in mg EQ TROLOX. This Table 6 presents two examples of the use of the food ration model with 50mg of lycopene. In the first column the times of food are presented, in the second the foods that are part of the menu 1 where the rations containing 50mg of lycopene are included. In the third column the example of menu 2 following the same characteristics. The total caloric value is 1500 kilocalories with a macro nutrient distribution of: 65% carbohydrates, 15% proteins and 20% lipids.

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Conflict of Interest

The authors declare that this paper is written in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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