Chemical and Physical Properties of "İsot" Type Pepper During Production

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Supervisor

Assist Prof. Dr. K. Bülent BELİBAĞLI

Selin ENGİN

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Name of the student: Selin ENGİN

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Approval of the Graduate School of Natural and Applied Sciences

Assoc.Prof. Dr. Metin BEDİR
Director

I certify that this thesis satisfies all the requirement as a thesis for the degree of Master of Science.

Prof. Dr.Ali Rıza TEKİN

Head of Department

This is the certify that I have read this thesis and that my opinion it is fully adequate, in scope and quality, as a thesis fort the degree of Master of Science.

Assist Prof. Dr. K. Bülent BELİBAĞLI
Supervisor

This is the certify that we have read this thesis and that our consensus/majority opinion it is fully adequate, in scope and quality, as a thesis fort the degree of Master of Science.

<u>Examine Committee Members</u>	Signature
Assoc. Prof. Dr. Abuzer ÇELEKLI	....
Assist Prof. Dr. Coşkun DALGIÇ	....
Assist. Prof. Dr.K. Bülent BELİBAĞLI	....

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Selin ENGİN

ABSTRACT

CHEMICAL AND PHYSICAL PROPERTIES OF "İSOT" TYPE PEPPER DURING PRODUCTION

ENGİN, Selin

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"İsot" is a kind of spice which is produced from red pepper and has a special color (black, red, and purple), smell, and taste. It is used in various products. İsot production can be achieved in two ways; industrial and traditional methods. In this study, the analyses and relationships of color, acidity, total phenolic content, ascorbic acid, antioxidant content, pH, non-enzymatic browning, and capsaicin content of isot pepper obtained from industrially simulated at 25,35,45°C,open atmosphere conditions; traditionally simulated and factory produced samples were examined from fresh pepper samples to final "isot" product by time.

All samples generally showed an decrease in pH and increase in the acidity, decrease in moisture content, increase in the ASTA (American Spice Trade Association) color values, fluctuations in L*, a*, b* values, decrease in ascorbic acid content, increase in non-enzymatic browning index, decrease in antioxidant content, fluctuations in total phenolic content, and increase in the capsaicin by time.

Key words: "İsot" pepper, color, non-enzymatic browning index, capsaicin.

ÖZET

İSOT TİPİ BİBER ÜRETİMİ SIRASINDAKİ BAZI FİZİKSEL VE KİMYASAL ÖZELLİKLER

ENGİN, Selin

Yüksek Lisans Tezi, Gıda Müh. Bölümü

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İsot kırmızıbiberden elde edilen ve kendine has renk (siyah - kırmızı-mor), tat, koku ve aroması olan bir baharattır.Bir çok üründe kullanılmaktadır. İsot üretimi endüstriyel ve geleneksel olmak üzere ikiye ayrılır.Bu çalışmadaendüstriyel ve geleneksel yöntemler kullanılarak değişik sıcaklıklarda (25,35,45°C ve açık havada) üretilmiş isot biberinin ve fabrikadan alınmış orijinal numunelerin ham maddeden son ürün oluşumuna kadarki süreçte alınan numunelerinde nem,renk, asitlik, toplam fenolik madde, askorbik asit,antioksidant, pH,enzimatik olmayan kararma,ve "capcaicin" tayinleri yapılarak bu süreçteki değişimler gözlenmiş ve birbirleriyle olan ilişkileri incelenmiştir.

İsot oluşum aşamasında pH değerinde bir azalma ve asitlik değerinde bir artma, in L*, a*, b* değerlerinde dalgalanmalarASTArenk değerinde bir artma, toplam fenolik madde miktarlaında dalgalanmalar, capsaicin miktarında bir artma, C vitamini değerinde bir azalma, antioksidan miktarında birazalma ve enzimatik olmayan kararma indeksinde bir artış görülmektedir.

Anahtar Kelimeler: ISOT biberi, renk, enzimatik olmayan kararma ve "capsaicin"

TO MY FATHER and MOTHER

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ABREVIATIONS

AOAC	Association of Official Analytical Chemists
ASTA	American Spice Trade Association
ANOVA	Analysis of Variance
a*	Redness-greenness
b*	Yellowness-darkness
L*	Lightness-darkness
FAO	Food and Agricultural Organization
C	Capsaicin
DHC	Dihydrocapcaicin
DPPH	2,2-diphenyl-1-picrylhydracyl
I	Industrial
HDHC	Homodihydrocapcaicin
HC	Homocapcaicin
NDHC	Nordihydrocapcaicin
PAVA	Nonivamide
ST	Simulated Traditional
SI	Simulated Industrial

CHAPTER I

INTRODUCTION

“İsot” is a traditional spice and widely used particularly in southeastern part of Turkey. For a long time, “isot” was produced traditionally for family consumption and partly marketing. Nowadays modern technology has increased the product quality and improved storage conditions. So isot becomes popular.

“İsot” is a kind of hot spices which has a special taste, aroma and color, produced from *Capsicum annuum L*. Production of “İsot” is discussed in section 2.2 in details.

Red peppers have been consumed for 2000 years as fresh, dried, pepper flakes, chili powders and recent years “isot”. The differences between isot and other pepper products are isot’s characteristics taste and aroma.

Red pepper which is used for “isot” production comes from Solanaceae family and botanic name is *Capsicum annuum L*., is grown in many places in the world. Chilli and paprika belong to *capsicum annuum* species, while the peppers which are very hot belong to *capsicum frutescens* species. Capsicum is the common name of C*apsicum annuum* and *Capsicum frutescens* species (Govindarajan, 1985).

In Turkey, hot red pepper production for spices changes according to years between 20-40 million tons. In terms of production amounts, first one is pepper flakes, the second one is powder type and the third one is the isot production (8-12 % of the total production). This portion is usually consumed in “lahmacun” and particularly in “çiğköfte”.

The red pepper for isot making is usually grown in Kahramanmaraş, Gaziantep, Şanlıurfa and Hatay. The red peppers are nearly 35-40 g weight and 8-12 cm height, 5-6 cm diameter. Fruits initially have dark green color and then they turn into red color when they are reached maturation.

Drying is the main processing step of ısot production. Drying technique is also important for isot production which affects the quality and properties of end product.

Drying can either be done by traditional sun drying or industrially through the use of solar dryers or hot air drying systems.

There is little information found in literature about isot. ((Poyrazoğlu et al., 2005, (Erdoğan, 2004)) However, there are a lot of information about red pepper spices. Most of the studies are related to drying process. İsot and dried red pepper could show some similarities in physical and chemical properties because of the similar raw material and process.

1.1.Aim of the research

In this work isot was prepared in laboratory conditions similar to industrial production at 25 °C, 35 °C, 45 °C and industrial and traditional simulations at open atmosphere condition. The moisture content, pH, acidity, color, non enzymatic browning, vitamin C content, total phenolic content, capsaicinoid content, antioxidant content changes were observed every day during the production period.

Therefore the aim of the research was to;

1. Simulate the isot production at laboratory conditions

2. Monitor the following parameters; moisture content, pH, acidity, color, extractable color, non enzymatic browning, vitamin C content, total phenolic content, capsaicinoid content, antioxidant content during isot production.

3. Compare the results with industrially produced samples.

CHAPTER II

LITERATURE REVIEW

2.1. Red Pepper(Paprika (*Capsicum annuum L.*)

Capsicum is a genus of flowering plants in the nightshade family Solanaceae. Its species are native to the Americas where they have been cultivated for thousands of years. In modern times, it is cultivated worldwide, and is mainly used in many regional cuisines. In addition to use as spices and food vegetables, capsicum has also found a use in medicines.

The fruit of Capsicum plants have a variety of names depending on place and type. The spicy variety is commonly called chili peppers, or simply "chilies". The large mild form is called red pepper, green pepper or bell pepper in North America, sweet pepper in Britain, and typically just "capsicum" in Australia, New Zealand, and India. The fruit is called paprika in some other countries (although paprika can also refer to the powdered spice made from various capsicum fruit).

Assumed that today there are nearly 20 types of pepper. The most knowns are *Capsicum annuum, Capsicum frutescens, Capsicum chinense, Capsicum pendulum and Capsicum pubescens.* Shapes and colors of different varieties of peppers are shown in Figure 2.1.

Figure2.1. Peppers in different shapes and colors belongs to Capsicum

2.1.1. Pepper Composition

The chemical composition of peppers for raw green, raw red and chilli peppers is shown in Table 2.1. The species had a significant effect on the chemical composition. For example, energy content of peppers ranged from 21 to 113 Kcals.

Table2.1. Composıtıon of pepper for 100 gr

	Raw green	**Raw red**	**Chilies**
Water (g)	92.1	92.1	92.5
Energy (kcal)	113	113	21
Fat (g)	0.19	0.19	0.10
Protein(g)	0.89	0.89	0.90
Carbohydrates (g)	6.43	6.43	5.3
Fiber (g)	1.8	2	1.3
Potassium (mg)	177	177	187
Phosphorous (mg)	19	19	17
Magnessium (mg)	10	10	14
Calcium (mg)	9	9	7
Vitamin C (mg)	89.3	190	68
Vitamin B2 (mg)	0.03	0.03	0.05
Vitamin B6 (mg)	0.248	0.248	0.153
Vitamin A (IU)	632	5700	610
Vitamin E (mg)	0.69	0.69	0.69
Niacine (mg)	0.5	0.5	0.8

Source: USDA Nutrient Data Base

The hot pepper has a number of i ndustrial uses as can be seen in Table 2.2.

Table 2.2 Industrial Uses of Pepper

INDUSTRY (end user)	PRODUCT TYPE	PEPPER PRODUCTS USED
Spice and Condiment industry	Pepper in Brine Sauces & salsas Seasonings	Fresh pepper Ground pepper Hot pepper mash
Ethnic Food Industry (mainly in European market)	Processed meats Hot sauces Dips Candy	Grounded pepper Hot pepper mash
Pharmaceutical Industry	Topical creams	Capsaicin oil, oleoresins
Health & Wellness Industry	Capsules	Grounded pepper
Defence industry	Stun guns Pepper sprays	Capsaicin oil, oleoresins
Fiery Foods Industry (mainly in US market)	Extra hot sauces (not for human consumption)	Capsaicin oil, oleoresins
Restaurant and Food Catering Industry	Gourmet sauces Marinades Table sauces	Fresh pepper Hot pepper mash Grounded hot pepper
Home Décor Industry	Decorative pieces	Fresh pepper

Source::http://www.unctad.info/en/Infocomm/AACP-Products/COMMODITY-PROFILE---Spices/

2.1.2. Importance of Pepper In The World Market

The top nine pepper producing countries are listed in Figure 2.2 below. (FAO, 2009).China is the top producers of Chillies & Pepper and . Turkey is in the third line in isot production after China and Mexica in the World(Figure 2.2.).

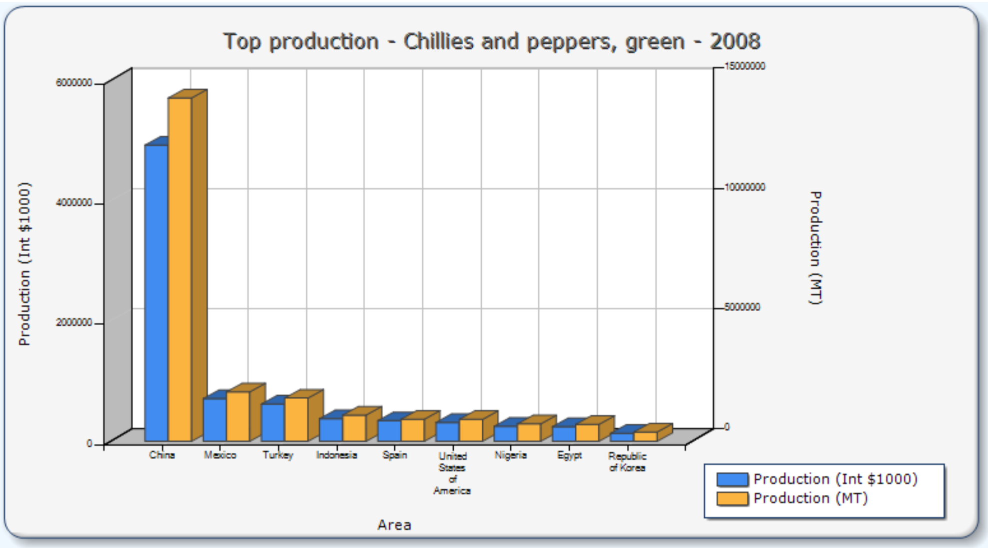


Figure2.2. Production of pepper in the World (FAO, 2009).

Production of "Pepper" has not been relatively stable over the years in Turkey. In 2010, production stood at 186000 tones (TÜİK, 2011). The production areas and amounts are listed in Table 2.3.

Table 2.3. Production area of red pepper and production amount

Year	Area(decare)	Production (Ton)	Year	Area(decare)	Production (Ton)
1988	63 670	20 953	**2000**	80 940	21 340
1989	86 200	21 303	**2001**	90 000	20 000
1990	83 610	24 216	**2002**	70 000	30 000
1991	68 020	20 921	**2003**	100 000	40 000
1992	60 790	16 136	**2004**	71 600	30 000
1993	56 400	14 492	**2005**	78 000	45 000
1994	58 810	14 878	**2006**	66 960	45 861
1995	57 840	13 887	**2007**	71 285	67 213
1996	61 520	14 750	**2008**	77 747	60 000
1997	63 200	14 466	**2009**	91 372	196 900
1998	61 900	14 333	**2010**	104 049	186 272
1999	57 730	16 080			

Source:(2011 TÜİK Spice Report)

2.1.3. Kahramanmaraş type red pepper

Kahramanmaraş region (including Adıyaman, Gaziantep, Kilis, Şanlıurfa) is major production area of red hot pepper (Figure 2.3) as spices and isot pepper. Because of its own specific color, aroma, taste, and pungency, high quality spices are produced.

Figure 2.3. Kahramanmaraş type red pepper

2.2. Technology of isot production

There are two kinds of production of isot. One of them is traditional production the other one is the industrial production.

Fresh red pepper

↓

Cleaning

↓

Sorting stems and seeds

↓

Discoloring on concrete (one day)

↓

Putting in to transparent, elastic PVC bags (day time)

↓

Put in cloth bags and they are bundled (at nights)

↓

Grinding of peppers after drying

↓

Addition of salt and oil

Figure 2.4. Flow chart of traditional isot production

Production scheme of traditional isot is given in Figure 2.4. Firstly raw red peppers which are suitable for isot production are cleaned and their stems and seeds are removed after that they are spread out onto concrete for one day to withering and discoloration. They are then put in to PVC bags or covered with the PVC bags are opened during the day time and closed during the night time (Figure 2.5). This process continues until the peppers are dried. The drying process takes 5 to 9 days depending on the weather conditions. After drying peppers are grinded and mixed with salt and vegetable oil. The desired isot (bright and well-colored) is then obtained.

Figure 2.5. Photos of traditional isot production.

(Taken from http://www.kemalvuraltarlan.com/isot-story.html)

Production scheme of industrial isot is given in Figure 2.6. There are some differences between traditional and industrial ısot production. Firstly raw red peppers (having 82-87 % moisture content) which are suitable for isot production are taken and their stems are separated but seeds are not removed. They cut in to 1 cm thickness. If the isot production will be done later, moisture content is decreased to 4% at 54-74°C by a hot air drying systems. If it is processed immediately, step-5 is skipped. The dried red peppers and dried seeds are tempered until they reach to 20-30% moisture content. They are then grinded according to desired size are mixed (30 % seed+ 70 % dried fruit). The mixture is passed through screw to compress them. Aim of this part is to increase the temperature. After compressing, the mixture of pepper fruit and seeds are put in to the bags covered with tent canvases. This prevents heat losses. In this step, temperature is increased to nearly 94 °C step by itself and the temperature starts to decrease. Desired isot is obtained when moisture content is reached to 12 %.

Fresh red pepper (82-87% moisture content) – step 1

↓

Cleaning - step 2

↓

Sorting stems - step 3

↓

Cutting into 1 cm thickness - step 4

↓

Dryıng (until 4% moisture content, at 54-74°C) - step 5

↓

Tempering dried red peppers and dried seeds until reach 20-30% moisture content- step 6

↓

Grinding of pepper seeds and fruits - step 7

↓

Mixing (30 % seed+ 70 % dried fruit) - step 8

↓

Compress in helix with screws - step 9

(Temperature rise nearly 54 °C)

↓

Mixture is put in to the bags over and over and covered with canvas - step 10

(Temperature is increase to nearly 94 °C step by step and after this point temperature is again start to decrease and moisture content reached to 12 %)

↓

Addition of salt (6%) and oil (6%) - step 11

↓

Packaging - step 12

Figure 2.6. Flow chart of industrial isot production

Figure 2.7 shows industrial isot production. Washing, cleaning and drying processes are shown only.

Figure 2.7. Photo of Industrial İsot Production

2.3. Characteristic of red pepper

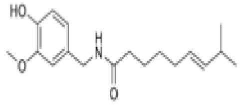
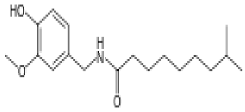
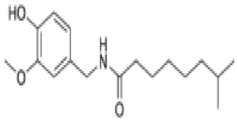
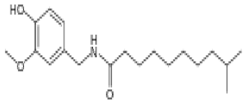
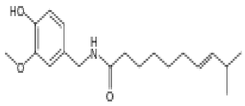
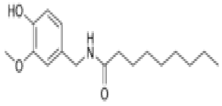
2.3.1. Pungency

Pungency is a strong odor or taste property referred to as hotness for chilli pepper.

Pungency is based on the concentration of capsaicinoids, primarily of capsaicin. The capsaicin is concentrated in the placenta area (white pith where seeds are attached). 60% of capsaicin is in the white pith and 40% in the seeds.

Capsaicin is the main capsaicinoid in chili peppers, followed by dihydrocapsaicin. These two compounds are also about twice as potent to the taste and nerves as the minor capsaicinoids, nordihydrocapsaicin, homodihydrocapsaicin and homo capsaicin. Table 2.4 shows properties of various capcaicinoids. Pure capsaicin is a hydrophobic, colorless, odorless, and crystalline to waxy compound.

Table 2.4. Properties of capcaicinoids

Capcaicinoid name	Abbrev.	Typical relative amount	Scoville heat units	Chemical structure
Capsaicin	C	69%	16,000,000	
Dihydrocapsaicin	DHC	22%	16,000,000	
Nordihydrocapsaicin	NDHC	7%	9,100,000	
Homodihydrocapsaicin	HDHC	1%	8,600,000	
Homocapsaicin	HC	1%	8,600,000	
Nonivamide	PAVA		9,200,000	

2.3.2. Color

The intense and characteristic red color of Capsicum fruits is principally due to the pigments of capsanthin and capsorubin. They belong to carotenoids, which are present in the chloroplast of red pepper as partially esterified with fatty acids.

Capsanthin and capsorubin are the major red pigments and are unique to the capsicum species. Capsanthin, which is commonly esterified with fatty acids as monoesters and diesters, as well as in free form, may represent as much as 50% of the total carotenoids (Locey and Guzinski, 2000). Especially capsanthin is regarded as a functional material because of its properties of stimulating singlet oxygen-quenching ability (Hirayama et al., 1994) and preventing colon carcinogenesis.

2.4. Changes in the characteristics of ısot during production

2.4.1. Drying

Dehydration is an important preservation process which reduces water activity through the decrease of water content, avoiding potential deterioration and contamination during long storage periods. Also, food quality of is preserved, the hygienic conditions are improved, and product loss is diminished (Kaymak and Ertekin, 2002).

A very common method of preservation for these agricultural corps is to dry them in order to conserve the perishable fruits, reduce storage volume and to extend their shelf life beyond the few weeks when they are in season Drying can either be done by traditional sun drying or industrially through the use of solar dryers or hot air drying (Riva and Peri, 1986). However both traditional and industrial sun-drying methods (i.e. drying with forms of solar energy) though having low operational installation and energy costs, still are labor intensive because of climatic variations. The use of solar drying may result in quality degradation of the final dehydrated products. The use of hot-air drying is a viable option for drying fruits and vegetables because of the large amounts of fruits produced annually which have to be dried for preservation and the fact that climatic factors do not affect the drying process.

Several factors can influence hot-air drying of food, for example: velocity and temperature of air, water diffusion through material, load density, thickness and shape of the product to be dried. However, the sudden removal of water decreases the nutritional and sensorial value of food, and allows the presence of phenomena such as hardening and shrinkage and it is well known that during hot-air drying, vegetables undergo physical, structural, chemical and nutritional changes that can affect quality attributes like texture, color, flavor, and nutritional value (Di Scala and Crapiste, 2008).

The increasing demand for high-quality shelf-stable dried vegetables requires the design, simulation and further optimization of the drying process with the purpose of accomplishing not only the efficiency of the process but also the final quality of the dry product. During drying, vegetables undergo physical, structural, chemical, organoleptic and nutritional changes that cause quality degradation (Crapiste, 2000; Di Scala and Crapiste, 2008). An adequate preservation method must decrease the water activity (up to values where microbial activity and other reactions are inhibited) and maintain the texture, mechanical properties, nutritional values, physical properties, etc.

Some studies cited in the literature have addressed the influence of drying conditions on the quality characteristics of the dehydrated product (Simal et al., 2005). Conventional drying of pepper causes a major loss of color and texture quality of the final product. Undesirable changes in the color may lead to a decrease in its quality and marketing value, therefore, the surface color of the pepper is an important criterion. Loss of red color is caused by autoxidation of carotenoids. The stability of the main carotenoids of the red bell pepper during storage has been shown to depend on the drying conditions, with the rate of deterioration increasing as the drying temperature increases (Doymaz and Pala, 2002; Vega GaLvez et al., 2008).

Kim et al.(2006) dried red peppers at 80 ◦C for 5h, then 60 ◦C for 18 h or 70 ◦C for 6h; short time and low temperature drying of cutpods, was reported to be more effective than conventional drying in reducing the destruction of the antioxidant activity, ascorbic acid and color.

Scala and Crapiste (2008) dried a thin layer of red pepper samples in across flow laboratory scale dryer with air at 50, 60 and70 ºC, ambient relative humidity and 0.2 and 1.2 m/s air velocity. They represented the drying kinetics by a diffusive model, the effective moisture diffusivity ranging from 5.01 to $8.32\times10^{-10} m^2/s$ with activation energy of 23.35 kJ/mol.

Tunde and Akintunde et al. (2005) dried red bell-peppers using sun, solar and artificial (i.e. hot-air) drying. The drying curves and rates obtained indicated that drying of bell-pepper was done in two drying rate periods, the constant drying rate period (mainly) and the falling drying rate period. The existence of the constant drying rate period was more pronounced in the artificial air-drying method than in the other two drying methods and the drying process was also faster. This was attributed to the effect of temperature of drying air on the diffusion of water from internal regions to the surface of the product.

Arslan and Özcan (2010) were dried red bell peppers with oven, sun and microwave oven drying and observed change in drying behavior, color and antioxidant content.

The sun, oven (50 and 70 °C) and microwave oven (210 and 700W) drying behaviors of red bell-pepper slices were investigated. Effects of these drying methods in terms of color indices and antioxidant activity of pepper slices were also studied. Sun dried and followed by microwave oven (700W) dried samples revealed the highest L*, a* and b* color values than the other dried samples. Microwave oven dried (210W) and oven dried (50 ºC) samples exhibited the lowest Trolox equivalent antioxidant capacity (TEAC) and DPPH radical scavenging activities among the dried samples.

Doymaz and Pala (2002) was studied drying kinetics of red peppers under different pretreatment and air drying conditions. Red peppers, *Capsicum annuum L,* grown in the region of Kahramanmaras, Turkey, were pretreated with various solutions of alkaline emulsion of ethyl oleate (AEEO) and dried afterwards. Results indicated that pretreated peppers dried faster and had higher Hunter L*(lightness), a* (redness) and b* (yellowness) values than the untreated and dried peppers. 2% ethyl oleate and 5% K_2CO_3 solution was found to be the most effective dipping solution that provided for whole peppers dried at 50 ºC, and yielded best color quality.

2.4.2. Moisture content

Pepper is categorized as perishable food due to its high moisture content but by drying it will be more stable, durable and nonperishable. It is known that ısot production is based on drying process. Drying is defined as a process of moisture removal due to simultaneous heat and mass transfer .The initial moisture content of raw red pepper which is suitable for isot production is between 82-87%. The final moisture content of isot is around 12%. İsot production involves initial drying process in which moisture content of fresh pepper is decreased from 82-87% to 20-30%. Isot is produced from peppers of 20-30% of moisture content.

2.4.3. Texture

The acceptability of dried products depends mainly on their structural properties (such as e texture), which is one of the attributes used by consumers in judging their quality. Destruction of the cellular system during drying causes important physical and structural changes.

2.4.4. Color

Capsicum annuum L show a tremendous variation in fruit and foliage size, shape, and color, and there are hundreds of varieties (Bailes, 1999). Pepper varieties differ greatly in pungency and color due to various breeding environments such as cultivating area, heat levels, water amounts and temperature. Furthermore, the deterioration of red pepper during processing is also a serious problem, affected by many factors including variety, moisture content, ripeness stage, and healthy state of dry fruits before grinding and drying condition. These affect the color of final products such as pepper powder.

Carotenoids pigments give their color to pepper. Drying process decreases the stability of the carotenoid pigments (Biacs et al., 1992).

Kim et al. (2004) studied the composition of main carotenoids in Korean red pepper (*Capsicum annuum, L.*) and changes of pigment stability during the drying and storage process This study was conducted to identify main carotenoids in red pepper and to investigate pigment stability during drying and storage. The main pigments in saponified extracts were capsanthin, zeaxanthin, ,β-cryptoxanthin, β-carotene, and an unknown peak, which was considered to be capsorubin by spectrophotometry and liquid chromatography/mass spectrometry (LC/MS). Myristoylcapsanthin, lauroylmyristoy lcapsanthin, and myristoylpalmitoylcapsanthin were identified from unsaponified extracts analyzing fragment ions by LC/MS.

Vega-Galvez et al. (2009) studied the effects of process temperatures between 50 and 90°C on physico-chemical properties, rehydration, colour, texture, vitamin C, antioxidant capacity and total phenolics during the drying of red pepper. The rehydration ratio decreased with temperature and the maximum water holding capacity was achieved at 50 °C. Both vitamin C content and the total phenolic content decreased as air-drying temperature decreased. The radical scavenging activity showed higher antioxidant activity at high temperatures (i.e. 80 and 90°C) rather than at low temperatures (i.e. 50, 60 and 70°C). Chromatic parameters (L*, a*, b*, C* and H), non-enzymatic browning compounds and extractable color were affected by drying temperature, which contributed to the discoloring of pepper during this process.

2.4.5. Time and temperature

Vega et al., (2009) studied the drying kinetics of the red bell pepper (var. Lamuyo) and modeled at different temperatures (50, 60, 70 and 80°C), using an air velocity of 2.5 m s^{-1}. Only the falling rate period was observed during the experiment. Effective moisture diffusivity was estimated to be between 3.2 $*10^{-9}$ and 11.2* 10^{-9} m^2 s^{-1}within the temperature range studied. The effect of temperature on the diffusivity was described by the Arrhenius equation with activation energy (Ea) of 39.70 kJ mol^{-1}. The Newton, Henderson–Pabis, Page and Page modified models were applied to the experimentally obtained moisture data. Comparisons of the experimental values with the calculated values demonstrated that the Page modified model produced the best fit for every drying curve, representing an excellent tool for estimation of the drying time.

Vega Galvez et al. (2008) dried red peppers at four air inlet temperatures from 50 to 80 ◦C and rehydrated in water at 30 ◦C to study the influence of air drying temperature on the quality and micro structural properties of the rehydrated tissue and also determined effects of sample pretreatment (immersing in a solution containing $NaCl_2CaCl_2$ and $Na_2S_2O_5$ prior to drying) and suggested that damage to cellular structure was minimized by pretreatment of samples; the resulting rehydrated peppers displayed comparatively improved vitamin C retention, color and firmness.

2.4.6. Capsaicinoid content

Capsaicinoids present in red peppers cause pungent, hot-tasting, sensations when consumed as part of the diet. The concentration of capsaicinoids in hot pepper varieties ranges from 0.003 to 0.01%; varieties of mild chillies contain from 0.5 to 0.3%, and strong chillies are characterized by a content higher than 0.3%, reaching about 1%, Perucka and Oleszek (2000).

Kurian and Starks (2002) are studied analysis of capsaicin and dihydrocapsaicin in whole chili peppers by HPLC. Peppers, both undried and dried, contained average values of 1250 ppm capsaicin and 540 ppm dihydrocapsaicin relative to undried weight. Relative to dry weight, the orange habañero peppers contained 8840 ppm capsaicin and 3940 ppm dihydrocapsaicin.

Topuz and Özdemir (2007) were studied assessment of carotenoids, capsaicinoids and ascorbic acid composition of some selected pepper cultivars (*Capsicum annuum*

L.) grown in Turkey by means of HPLC technique. The findings determined that the cultivars of 730 F1 and 1245 F1 had higher carotenoids (2310–2390 mg/kg in dry basis), capsaicinoids (471.3–688.1 mg/kg in dry basis), vitamin A (218.8–243.0 mg RAE/100 g in wet basis) and vitamin C (63.1–64.9 mg/100 g in wet basis) content, without any significant difference among each of them. Furthermore, the cultivars which had higher capsaicinoids contents had higher ascorbic acids content as well.

CHAPTER III

MATERIALS AND METHODS

3.1. Materials

Main material fresh Kahramanmaraş type (*Capsicum annuum L*) red pepper was bought from wholesale market of Gaziantep. After washing, cleaning and sorting processes, the drying process was conducted.

İsot samples produced by an industrial method were taken from Ölmez Agricultural Products Factory (Gaziantep, Turkey) every day during production.

All of the samples which are taken day by day are analyzed in the same day if not they were stored at -40°C until they were analyzed.

All chemicals used in this study were of analytical grade and purchased from Merck Chemical Co. (Darmstadt, Germany)

The samples named "**Industrial, (I)**" means the products obtained through the way as discussed in Figure 2.6 and discussed in details at section 2.2. This is a real industry production.

In this study, the sample named "**Simulated Traditional, (ST)**" means the products obtained through traditional way as discussed in Figure 2.4 and details are given at section 2.2.

In addition to these two methods, industrial production way was simulated at laboratory conditions with 3 different temperatures (25°C, 35°C, 45°C) and under atmospheric conditions. These are indicated as "**Simulated Industrial, (SI)**". "Kepertme" part in industrial production was also tried to be simulated by packing the samples tightly and pressurized by putting a stone on top of packages. For example, samples processed at 25 ^{o}C , 35°C,and 45°C are shown as "**SI-25"**"**SI-35"**"**SI-45",** respectively.

3.2. Methods

3.2.1. Moisture content determination

The moisture content was determined by the oven method according to Official Method of Analysis (AOAC, 1995).The measurements were carried out in triplicate.

3.2.2. Extractable color determination

The ASTA color value was measured using the ASTA Analytical Method 20.1 (1986). The ASTA color of the red pepper samples was measured by a spectrophotometer (Perkin Elmer Lampda 25Model). Red pepper powder (70–100 mg) was added to 100 mL of acetone, and then the mixture was stored at 0 °C for 4 h with intermittent stirring. The absorbance of an aliquot of the transparent extract was measured at 460 nm using a UV/VIS spectrophotometer. ASTA color value was calculated using the following equation:

$$\text{ASTA color value} = \frac{\text{absorbance of acetone extracts} * 16.4 * \mathbf{If}}{\text{sample weight(g)}}$$

Where “**If**” is a correction factor for the apparatus, which was calculated from the absorbance of a standard solution of potassium dichromate, ammonium sulphate and cobalt sulphate.

3.2.3. Surface color determination

The surface color measurement of isot samples were performed using Hunter Lab Color Flex (A60-1010-615 Model Colorimeter, Hunter Lab, and Reston VA) during production. The L*, a*, b* color values (also referred to as CIELAB) were used to express the color changes. The color values are express as L* (darkness/whiteness), a* (greenness/redness), b* (blueness/yellowness) values. Three measurements were taken for all samples and average values were shown. The instrument was calibrated against the standard reference white tile “L*=93.41, a*=-1.12, b*=1.07”.

3.2.4.DPPH radical scavenging activity determination

Antioxidant activity was evaluated by measuring the radical scavenging effect of dried peppers methanolic extracts towards the2,2-diphenyl-1-picrylhydracyl (DPPH) as reported previously by Singh et al. (2002) and Bamdad et al. (2006). 5mL of a 0.1mM methanol solution of DPPH (Fluka) was added to 0.1mL of methanol extracts of pepper samples. The tubes were allowed to stand at 27 ◦C for 20min. The decrease in absorbance at 517nm was recorded in a spectrophotometer (Perkin Elmer Lampda 25Model).Radical scavenging activity was expressed as inhibition percentage and was calculated using the following formula:

$$\text{percent radical scavening activity} = \left(\frac{\text{control OD} - \text{sample OD}}{\text{control OD}}\right) \times 100$$

3.2.5. Total Phenolic Content Determination

The total phenolic content of isot samples were determined by Folin-Ciocalteu Method (Singleton, Orthofer, Lamuela and Raventos, 1999) 250 µl of Folin-Ciocalteu reagent was added to 50 µl of sample. After 2 min. 750 µl of 20% (w/v) aqueous Na_2CO_3 solution was added and the volume was made up to 5.0 mL with water. The controls contained all the reaction reagents except the extract. After 2 h of incubation at 20 °C, absorbance was measured at 765 nm and compared with the gallic acid calibration curve. Total phenol content was determined as gallic acid equivelent mg gallic acid/g extract, and the value was presented as the mean of duplicate analysis.

3.2.6. Non Enzymatic Browning Index Determination

The methodology applied for determination of non-enzymatic browning compounds (NEB) solubilized in the rehydration water was proposed by Vega-Gálvez et al. (2008b). The rehydration water was first clarified by centrifugation at 3200×g for 10 min. The supernatant was diluted with an equal volume of ethanol at 95% and centrifuged again at 3200×g for 10 min. The browning index (absorbance at 420 nm) of the clear extracts was determined in quartz cuvettes using a spectrophotometer (Perkin Elmer Lampda 25 Model). All measurements were done in duplicate.

3.2.7. Vitamin C Determination

Vitamin C (Ascorbic Acid, AA) was determined based upon the quantitative discoloration of 2,6-dichlorophenol indophenols titrimetric method as described in AOAC methodology No. 967.21 (AOAC, 2000). The vitamin C content was expressed as mg AA retained/100 g dry matter. All measurements were done in duplicate.

3.2.8. pH determination

The pH value of the sample was determined using a pH meter (Jenway 3010; Jenway LTD, Essex, UK) equipped with a J95, 924001 electrode (Jenway LTD, Essex,UK). The measurement of pH value was carried out on 1 g of sample homogenized in distilled water (1/10: sample/water).

3.2.9. Acidity Determination

Titratable acidity was determined by potentiometric titration against 0.1 N NaOH to pH 8.2 and expressed in malic acid equivalents, the predominant acid in ripe bell pepper (Lunning et al., 1994)

3.2.10. Capcaicin Determination

Capsaicinoids were extracted from the samples of red pepper pastes by applying the technique described by Collins et al., 1995. The capsaicinoids were extracted from 2 g sample in 12mL acetonitrile by heating at 80 °C for 4 h. Suspensions were periodically shaken every 30 min throughout the extraction process. The suspended material was allowed to cool and settle. The supernatant was filtered into a 2mL glass vial using 0.45 mm membrane filter (Millipore) and used for HPLC injections. Liquid chromatography was performed using a HPLC solvent delivery system equipped with a fluorescence detector (RF-20 A, JAPAN) and Star software for data processor. The separation was performed on a Nucleosil 5 C18 column (250×4.6mm i.d.) coupled with a Nucleosil 5 C18 guard column (4×4.6mm i.d.). The following HPLC operating condition, used by Peusch et al. (1997), was employed. The eluent was a mixture of acetonitrile/water/acetic acid (100:100:1) at a flow rate of 1.2 mL/min. The fluorescence detector was set at 280nm excitations and 320 nm emissions. Injection volumes, run time and temperature were 20 mL, 23 min and 20–22 °C, respectively. Standards of capsaicin (98%), dihydrocapsaicin (90%) and mixture of capsaicinoids (60% capsaicin) were used for retention time verification and quantification.

CHAPTER IV

RESULT AND DISCUSSION

4.1. Moisture Content

İsot production is a kind of drying process. This provides desired texture, color, aroma and longer shelf life. The samples were dried with different methods and different temperatures discussed in section 3.1. The initial moisture content of our fresh pepper was 91.5% and it was decreased to nearly 13%.One way ANOVA analysis showed that (in appendix) a significant decrease in moisture content was observed($p<0,05$).

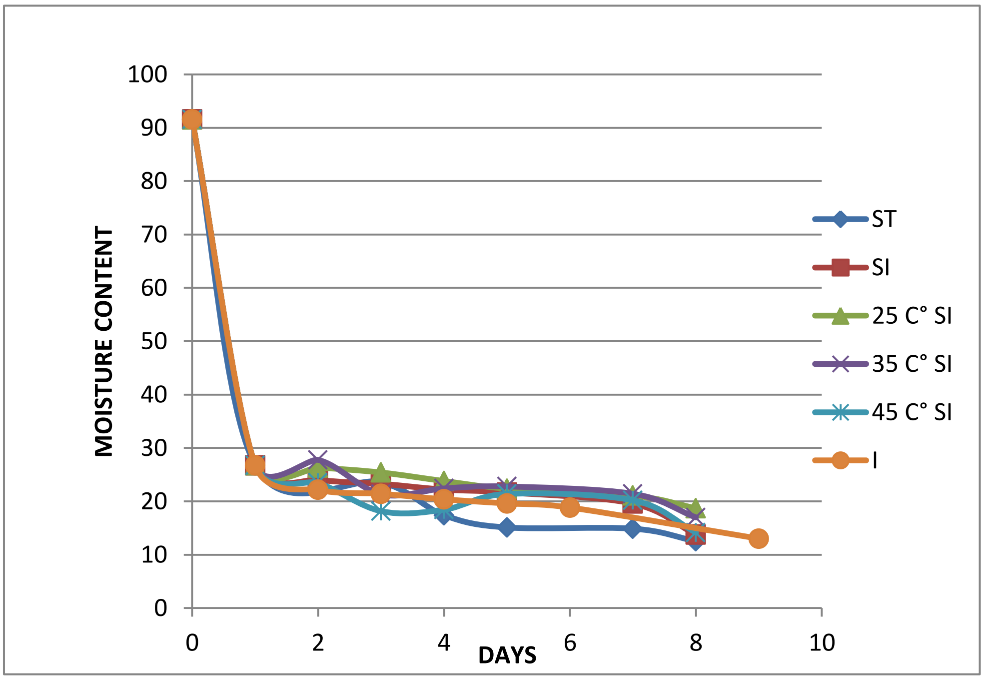


Figure 4.1. Plot of moisture content versus production days

The moisture content of the material was very high during the initial phase of the drying which resulted in high drying rates. Afterwards, moisture content for all samples was almost constant. In this study, drying rate calculations were not done. That is why, it is hard to say anything about the length and presence of falling and constant rate periods. However, Arslan and Özcan, (2010) reported that the entire drying process for the red pepper samples occurred in the range of falling rate period. Kaymak and Ertekin, (2002), Ade and Omowaye et al., (2003) reported that drying process took place in the falling rate period,

Drying times for all methods were selected as the same for all process (except original industrial sample). When the moisture contents are compared with respect to drying temperatures, small differences between dryings at 25, 35 and 45°C were observed but the moisture content decreases with the increasing temperature. When the drying methods are compared there are no significant differences ($p>0.05$) between simulated traditional and simulated industrial method according to statistical analyses.

4.2. Color of Isot

Pepper colors can be examined with the following ways (Tepić and Vujičić, 2004):1. surface (apparent) color, 2.extractable (ASTA) color, and 3. carotenoids profiles. Extractable and surface color measurements are the main quality methods used in the spice industry.

Type, degree of ripeness, granulation and processing methods are all affecting the final appearance of pepper. ASTA color affects the brightness of a product, while the surface color has an impact on the hue of the product. Hue sets the kind of color, e.g. brownish-red, orange-red cultivar.

Photos of pepper samples of simulated industrial production at 45 °C and those of industrial production are shown in Figure 4.2 and Figure 4.3, respectively. It is easy to follow formation of dark color at industrial production by time. However, the same dark color formation was not followed for simulated industrial products. Necessary conditions (lack of the followings: compact pressing during drying, use of large batches during processing and enough increase in temperature to approximately 90 ^{o}C during "kepertme") were not occurred for dark color formation.

Temperatures of the simulated industrial samples were constant at 25, 35, 45 °C throughout the isot production. However, in industrial production, temperatures of samples could have reached to 90-95 °C during "kepertme" process. In our simulation of industrial isot production, temperatures were lower than 90-95 °C, therefore expected biochemical reactions would have not been occurred.

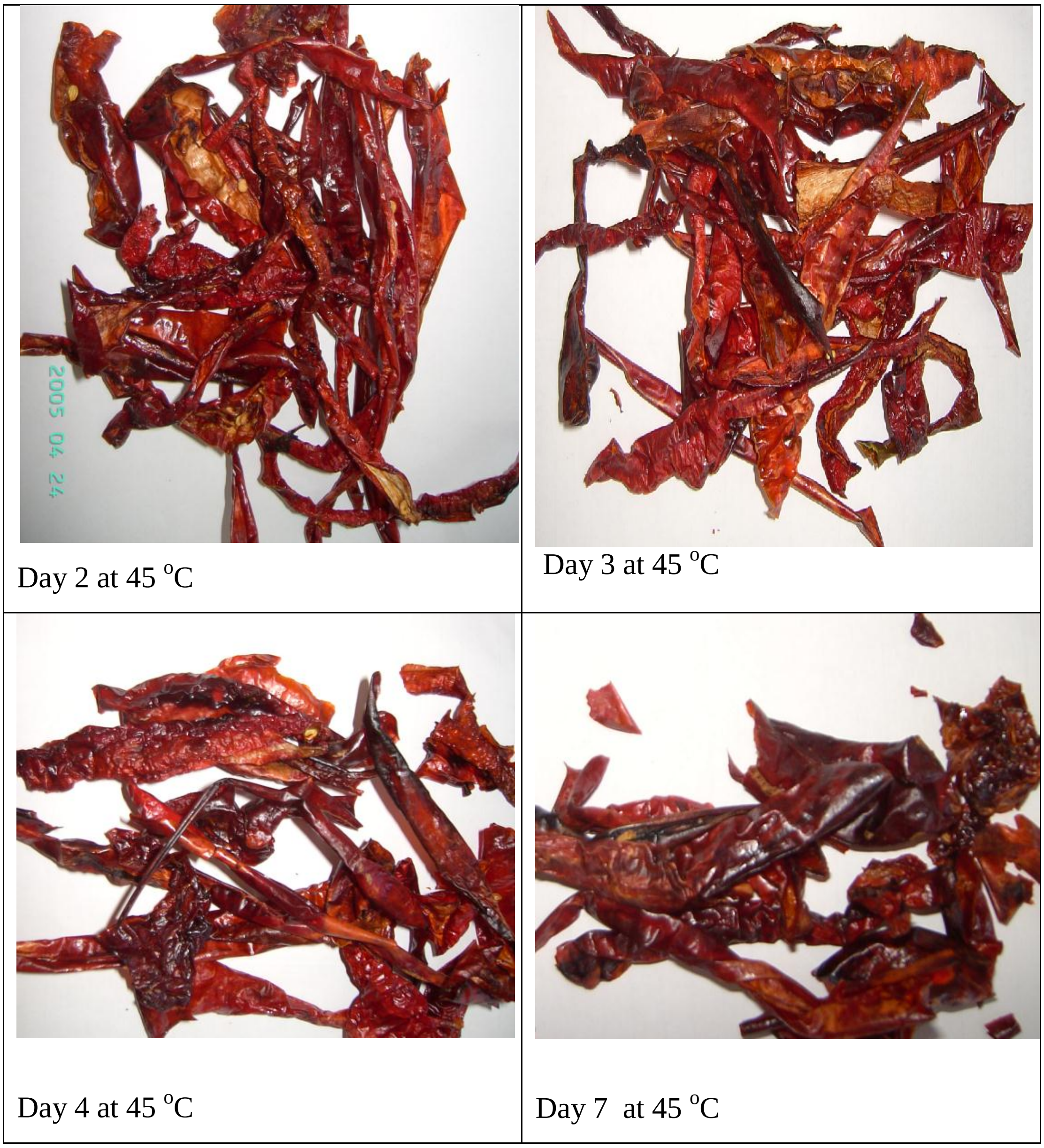


Figure 4.2. Pictures of peppers during simulated industrial production at 45 ^{o}C

Figure 4.3 Pictures of peppers during industrial production (from factory production)

“1. Gün”=Day 1 shows the grinded samples time just after the mechanically drying with moisture contents of 20-25%.

“3. Gün”= Day 3 shows the samples after compressing in screw (temperature rise nearly 54 °C),

“5. Gün”=Day 5 shows the samples after packaging in bags and covering them with canvas (temperature rise nearly 94 °C),

“8. Gün”= Day 8 shows the samples after addition of salt (6%) and oil (6%) and packaging

4.2.1. Surface Color

Surface color information provides to specify colors perceived by the human eye. It is very difficult to describe colors verbally, because two people might describe the same color by different terms. The light source and illumination, the back ground color and contrast, and the angle at which the object is viewed will affect specification of the color. Surface color of the peppers varies according to type, growing conditions, dehydration, milling and storage conditions.

Surface color measurement was determined by Hunter Lab Colorimeter. The color brightness coordinate L^* measures the whiteness value of a color and ranges from black at 0 to white at 100. The chromaticity coordinate a^* measures red when positive and green when negative, and chromaticity coordinate b^* measures yellow when positive and blue when negative (Doymaz et al., 2006).

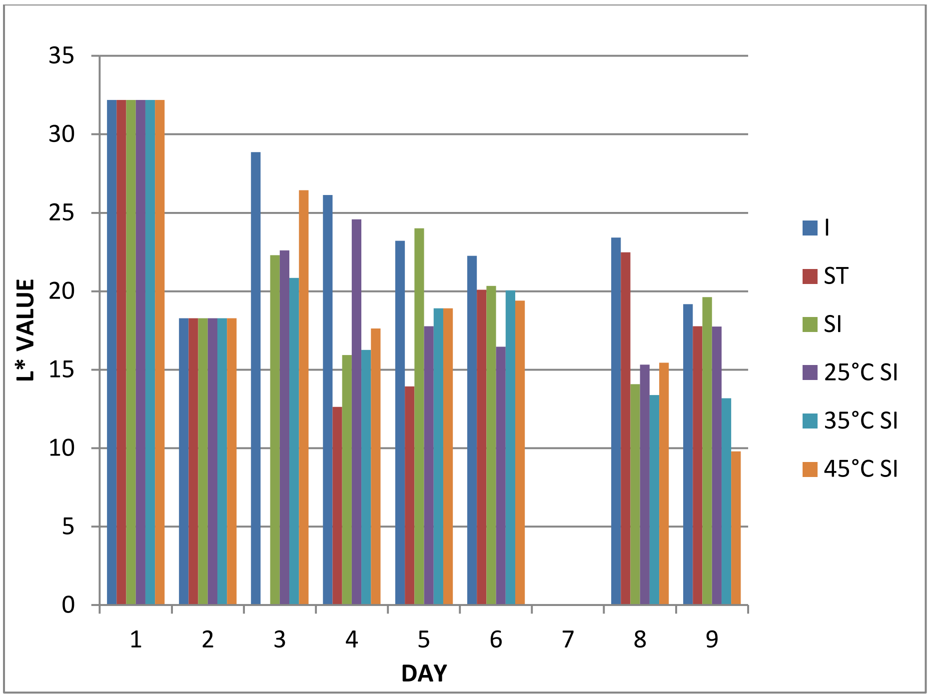


Figure 4.4. Plot of L values versus production days

Changes in L values of isot samples in production process by time are shown in Figure 4.4. Day 1 indicates the fresh samples. In general there are fluctuations in L-values of all samples. In all the conditions there was a decrease between the first day and the last day samples significantly ($p<0.05$ in appendix). All of the samples lost their brightness during isot production process. When the process was compared according to temperatures they were shown similar fluctuations. At the end of the processes, L* values decrease from 32.2 to 17.7 for the original isot sample and to 9.79 for the sample which was processed at 45°C, respectively.

The decrease in L^* values can be attributed to brown pigment formation during drying as Park and Lee (1975) reported that brown pigment in dried red peppers was due to their high levels of reducing sugars and amino acids in red pepper.

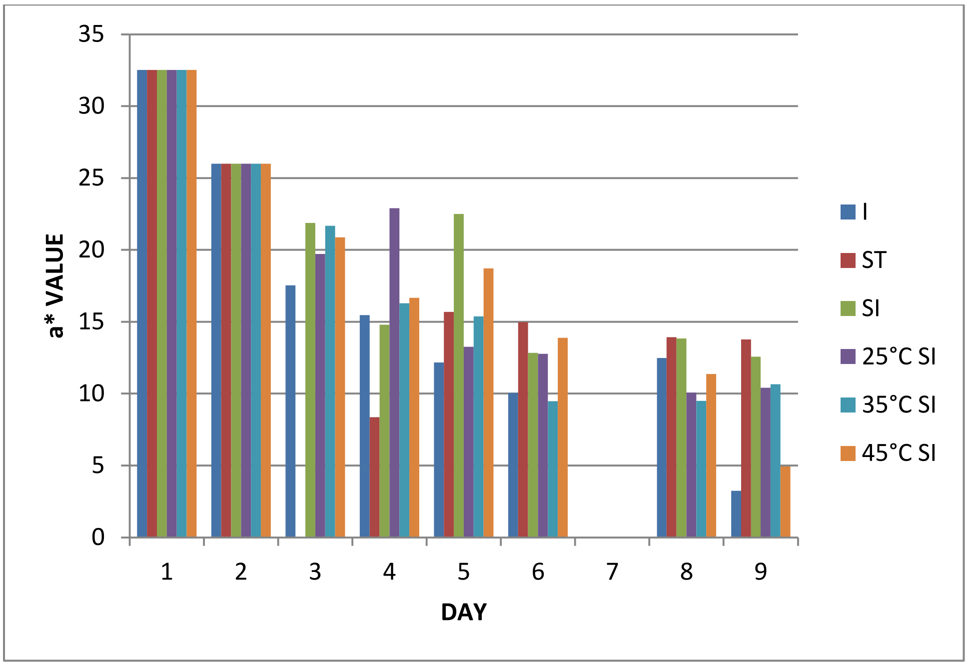


Figure 4.5. Plot of a* values versus production days

Changes in ‘a’ values of isot samples in production process by time are shown in Figure 4.5. In general there were fluctuations in a * values for all type of samples significantly ($p<0,05$ in appendix) , but a decrease in ‘a’ value from the first sample to the last sample was observed. It is a fact that isot samples lost their redness on their surfaces and turned to brownish color. The biggest change in a* value from initial to final stage was observed from 32.51 to 3.24 for the industrial sample. Arslan and Özcan (2010) dried red bell peppers by different methods, Results indicated that a^* values of fresh and sun dried samples were higher than microwave and oven dried samples

Changes in b values of isot samples in production process are shown in Figure 4.6. In general there were fluctuations in all type of sample significantly ($p<0,05$ in appendix) but a decrease in a value of b* from the first sample to last sample was observed. The maximum change between the initial and final stages was observed at the ones processed at 45° C of simulated industrial samples and the minimum change was in simulated traditional samples. In particular, the b* values suddenly decreased at day 4 (from 26.71 to 3.33) due to the decrease of redness caused by rapid discoloring during sunlight exposure for traditionally processed samples, After 4 days b* value increased to 10.05 at the end of isot production.

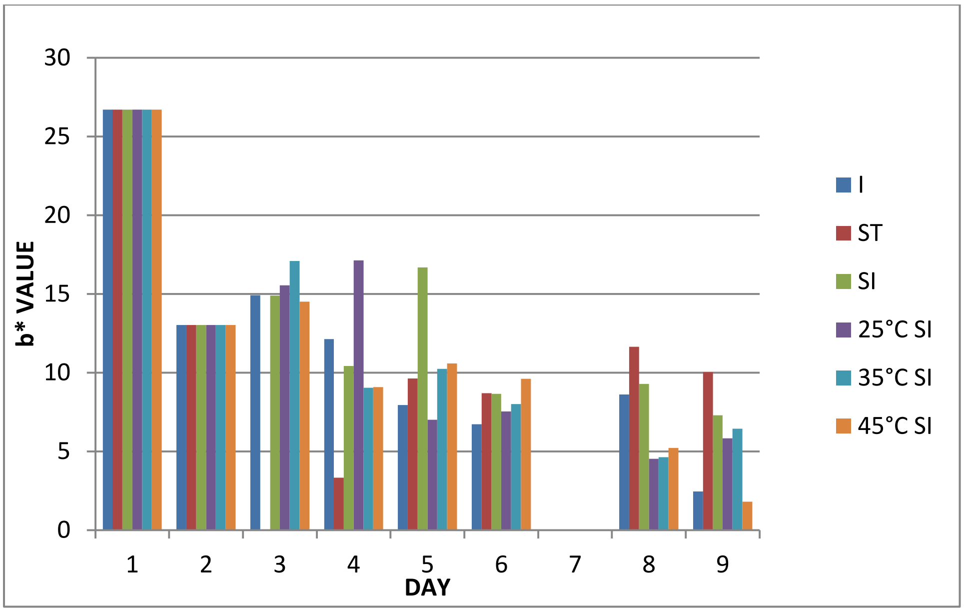


Figure 4.6. Plot of b* values versus production days

4.2.2. Extractable Color

Extractable color is a measure of total pigment content. Current procedures for measuring extractable color (total pigments) in dehydrated capsicums and oleoresins were developed and approved by the Association of Official Analytical Chemists (AOAC) and the American Spice Trade Association (ASTA). Extractable color is measured using a spectrophotometer and is expressed in ASTA units. Generally, the higher the ASTA color value, the greater the effect on the brightness or richness of the final product.

The present study showed that the ASTA values significantly ($P < 0.05$ in appendix) changed by drying methods. Change in ASTA color values of isot samples during production by traditional and industrial methods and 25°C, 35°C, 45°C are shown in Figure 4.7.

All samples were shown a similar increase trend. The highest ASTA value was recorded in pepper processed simulated industrially at 45 ^{o}C with the values of 189.5. In contrast, the, industrial and simulated industrial methods for the pepper yielded the lowest ASTA values without significant differences between each other. In industrial simulation process with different temperatures, there is an increase in ASTA color values in increasing temperature.

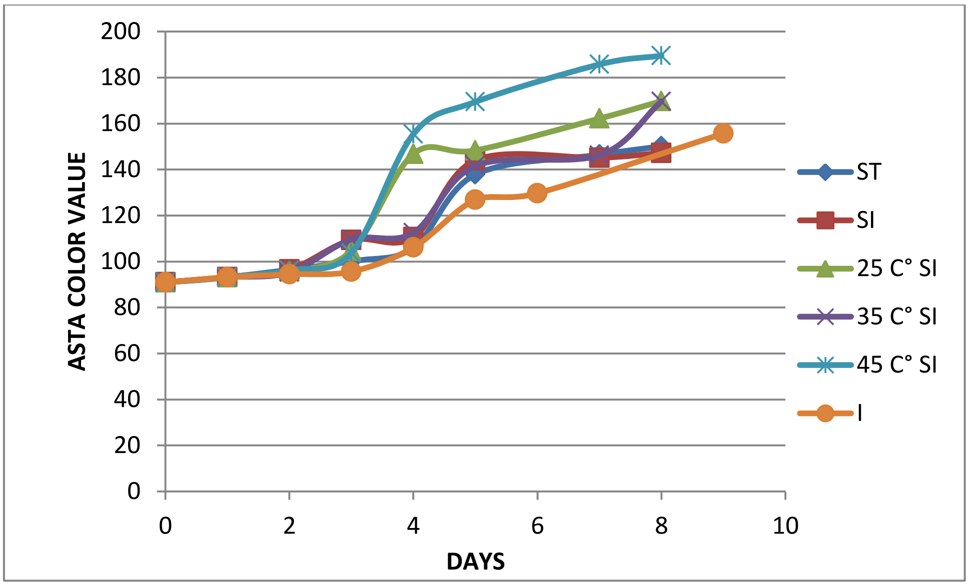


Figure 4.7. Plot of ASTA color value versus production days

The increase in ASTA values could be attributed to biosynthesis of carotenoids in living tissues. This phenomenon was also reported in previous research for slow drying processes (Minguez and Mosquera and Hornero-Mendez, 1994 and Minguez and Mosquera et al., 1994). The ASTA values of industrial samples were lower than those for all drying methods. The industrial isot production at the factory was being produced by oven drying. This provided better drying conditions.

Loss of red color is caused by autoxidation of carotenoids. The stability of the main carotenoids of the red bell pepper during storage has been shown to depend on the drying conditions, with the rate of deterioration increasing as the drying temperature increases (Doymaz and Pala, 2002; Vega-Galvez et al., 2008).

Some studies cited in the literature have addressed the influence of drying conditions on the quality characteristics of the products (Simal et al., 2005). Conventional drying of pepper causes a major loss of color and texture quality of the final product.

4.3. Antioxidant Activity

An antioxidant is a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons or hydrogen from a substance to an oxidizing agent. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reactions. When the chain reaction occurs in a cell, it can cause damage or death to the cell. Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation reactions. They do this by being oxidized themselves, so antioxidants are often reducing agents such as thiols, ascorbic acid, or polyphenols.

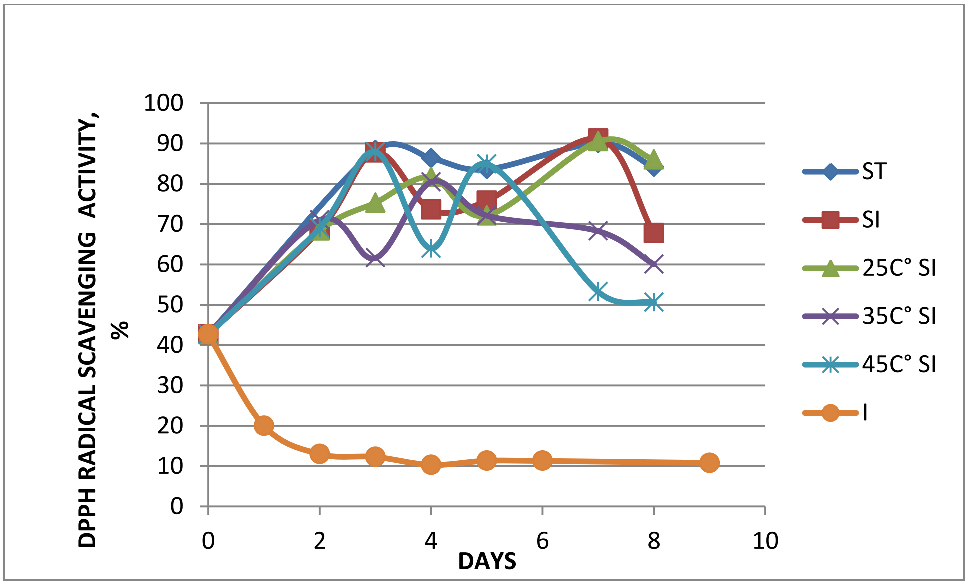


Figure 4.8. Plot of DPPH radical scavenging activity versus production days

Change of DPPH radical scavenging activity of isot samples are shown in Figure 4.8. In all of the samples (except the industrial sample) there were some fluctuations by time. When comparing the final values there were significant differences in each other. Samples of simulated traditional and industrial methods showed similar fluctuations at the same days. In contrast, considering the industrially simulated samples by process temperatures, antioxidant activity decreased with increasing process temperature.

When comparing the industrial sample with the others, the industrial sample was shown very low antioxidant activity with respect to those of the other isot samples. Reason of this situation could be the decrease in the metabolic activity of industrial sample. It was assumed that industrial sample might have completed its metabolic activity during the production process and so DPPH radical scavenging activity remained constant. In contrast, metabolic reactions in the other samples were continued during the production process because of the lack of industrial production process conditions.

Antonio Vega-Galvez et al. (2009) studied the effects of process temperatures between 50 and 90 °C on physicochemical properties, rehydration, color, texture, vitamin C, antioxidant capacity and total phenolics during the drying of red pepper. The radical scavenging activity showed higher antioxidant activity at high temperatures (i.e. 80 and 90 °C) rather than at low temperatures (i.e. 50, 60 and 70 °C). However, in this study it is hard to see a regular decrease or increase in radical scavenging activity, because of lack of necessary conditions for the reactions. The metabolic activities of the sample could have stopped in industrial sample due to the high temperature in the process.

4.4. Total Phenolic Content

Phenols, sometimes called phenolics, are a class of chemical compounds consisting of a hydroxyl group(—OH) bonded directly to an aromatic hydrocarbon group. Tota lphenoliccontent (TPC) was estimated as gallic acid equivalents (GAE) as described by Folin–Ciocalteau's (FC) method. Changes in mg gallic acid/gr extract values against to production days were shown in Figure4.9.There is not a significant difference between the initial and final values of TPC ($P>0.05$ in appendix). There were fluctuations in TPC values of all samples during the production because metabolic activity was expected to continue. Only there is a significant increase in the final value of the simulated traditional sample. It could be due to the insufficient process conditions compared with the industrial process. Maximum increase and the minimum decrease were determined in simulated traditional sample and the sample processed at 25°C, respectively.

Antonio Vega-Galvez et al.(2009) studied total phenolic content during drying of red pepper, a decrease in total phenolic content was determined as air-drying temperature decreased.

4.5. Ascorbic Acid

Vitamin C or L-ascorbic acid, or simply ascorbate (the anion of ascorbic acid), is an essential nutrient for humans and certain other animal species.

Ascorbic acid content increases with pepper fruit ripening while, losses during post harvest handlings (Martinez et al., 2005)

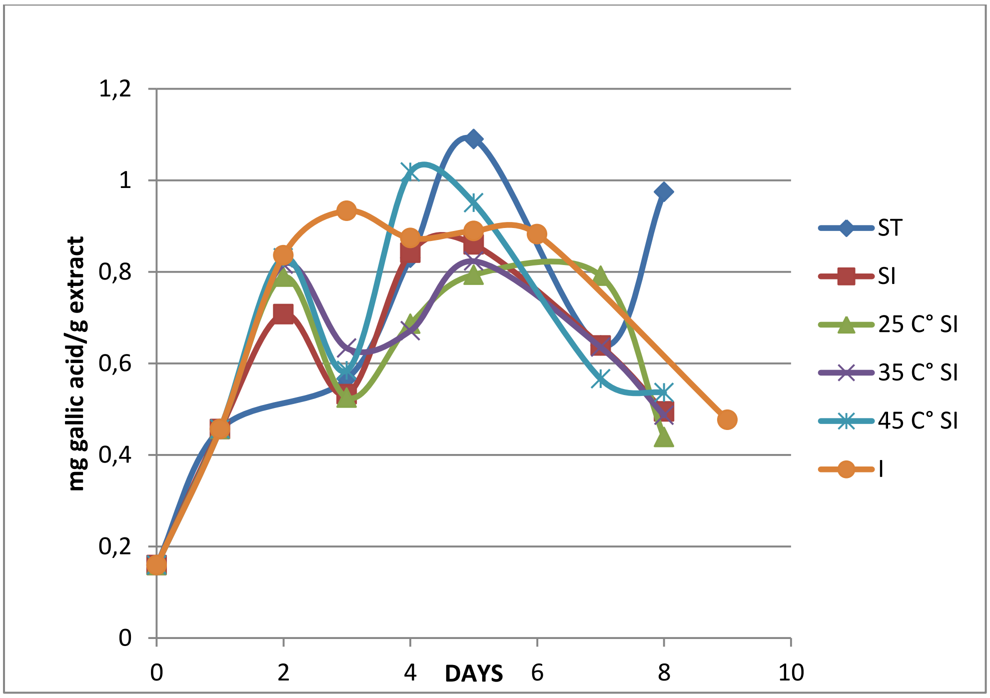


Figure 4.9. Plot of total phenolic content versus production days

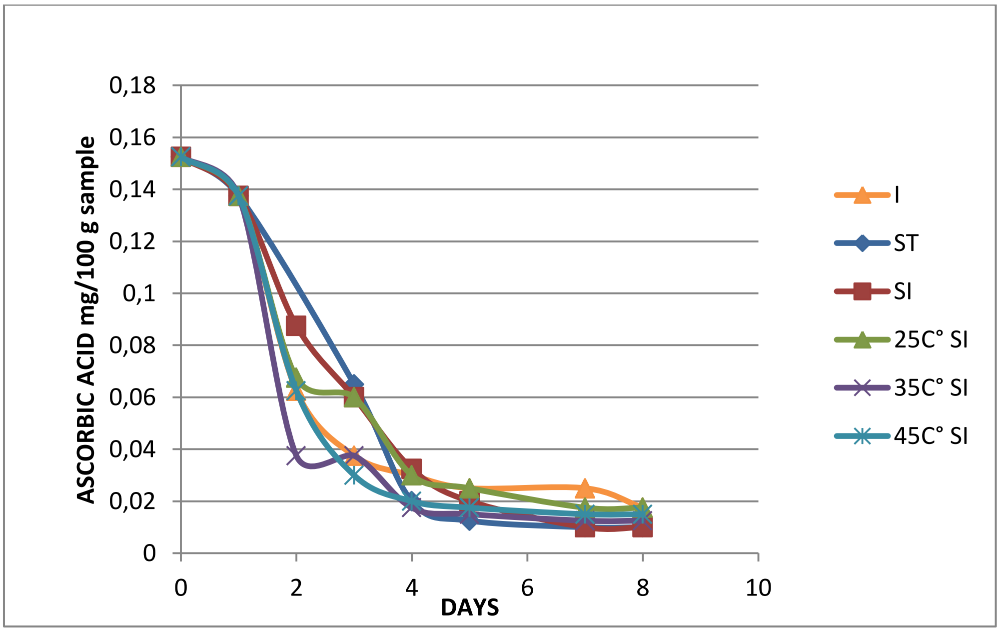


Figure 4.10. Plot of ascorbic acid content versus production days

Changes in amount of ascorbic acid of isot samples in production process are shown in Figure 4.10.Therewere a significant decreases in Vitamin C during the production($p<0,05$) because isot production is a kind of drying process and vitamins are heat sensitive substances. Inyang and Ike, (1998) reported that dried peppers after all rehydration contained less ascorbic acid than the fresh pepper due to a combination of leaching, oxidation and thermal destruction of ascorbic acid during hot-air drying and subsequent rehydration. The air drying temperature had a detrimental effect on the retention of ascorbic acid, as heated air inherently exposes the products oxidation, reducing their ascorbic acid content. In this study the ascorbic acid amounts were decreased during production similarly because isot production process is a kind of drying process. The maximum and minimum changes in were observed in samples of industrial method and in samples of simulated industrial production at 35°C, respectively.

4.6. Non-Enzymatic Browning

Non-enzymatic, or oxidative, browning is a chemical process that produces a brown color in foods without the activity of enzymes. The two main forms of non-enzymatic browning are caramelization and the Maillard reactions. Both vary in reaction rate as a function of water activity.

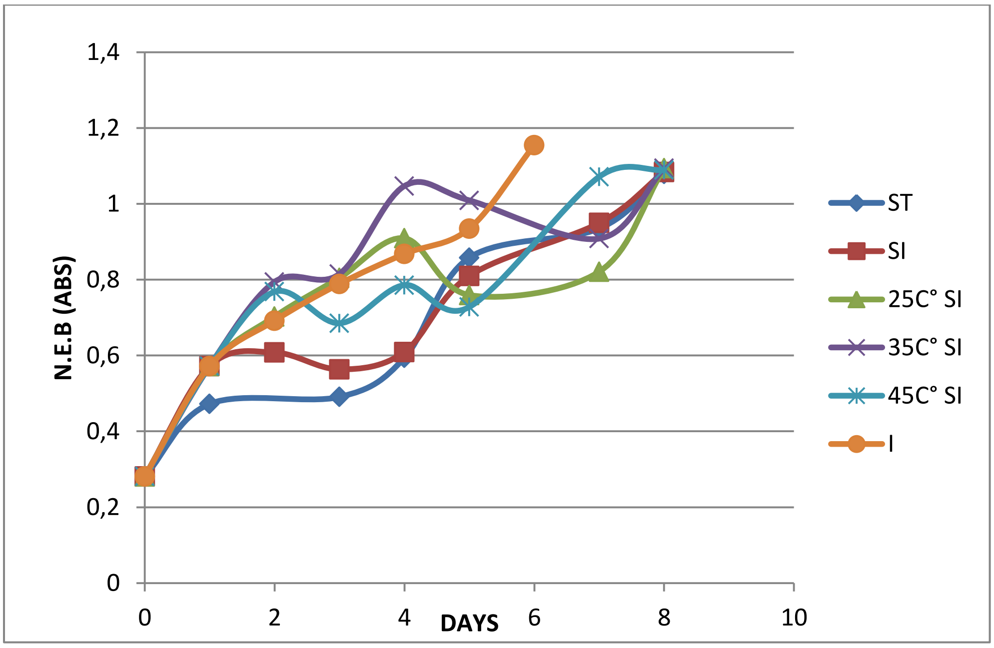


Figure 4.11. Plot of non-enzymatic browning content versus production days

Changes in non-enzymatic browning (NEB) of isot samples in production process are shown in Figure 4.11. There were a significant increase in absorbance (at 420nm) of isot samples during production ($p<0,05$ in appendix). Maximum change was in samples produced in industrial and the minimum change is in sample produced with simulated traditional method. The NEB values of all samples have not reached to the value of NEB for samples of the industrial method (factory produced). All methods excluding the industrial method possibly did not provide the necessary processing parameters such as pressure and temperature for the formation of brownish-dark color.

Tannenbaum and Young (1985) said that the decomposition of ascorbic acid was closely tied to the non-enzymic browning in some food products. So, the change of ascorbic acid contents shown in Figure 4.10may be related to the formation of browning products of non-enzymic browning reactions.

4.7. pH

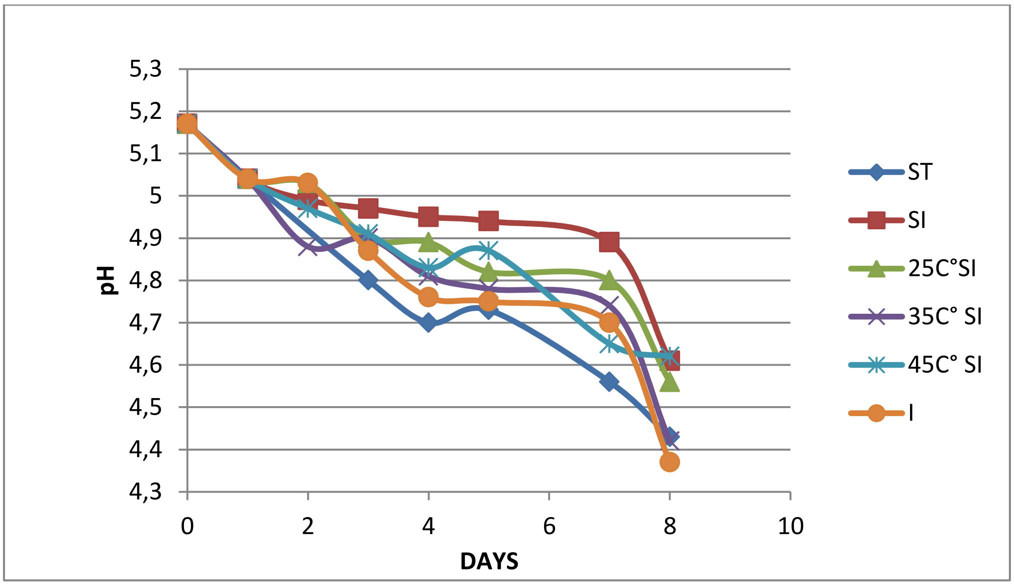


Figure 4.12. Plot of pH change versus production days

Changes in pH of isot samples in production process are shown in Figure 4.12.There were significant decreases in pH of isot samples by time and during production (p<0,05 in appendix) because of the acid formation. pH of the fresh pepper was 5.17 and after the production there was a significant decrease in all of the samples. Maximum change from 5.17 to 4.42 was in the sample produced at 35°C,minimum change from 5.17 to 4.62 was in the sample of produced at 45°C.The pH and titritable acidity values were significantly affected by the drying process (Özgür et al., 2011). However, the difference in pH between all samples were not significant

4.8. Acidity

In this study titratable acidity of our isot samples was determined by titration against 0.1 N NaOH and expressed in malic acid equivalents, as the predominant acid in bell pepper. Vega-Gálvez et al. (2009) also expressed the level of titratable acidity as malic acid in dried Hungarian red peppers.

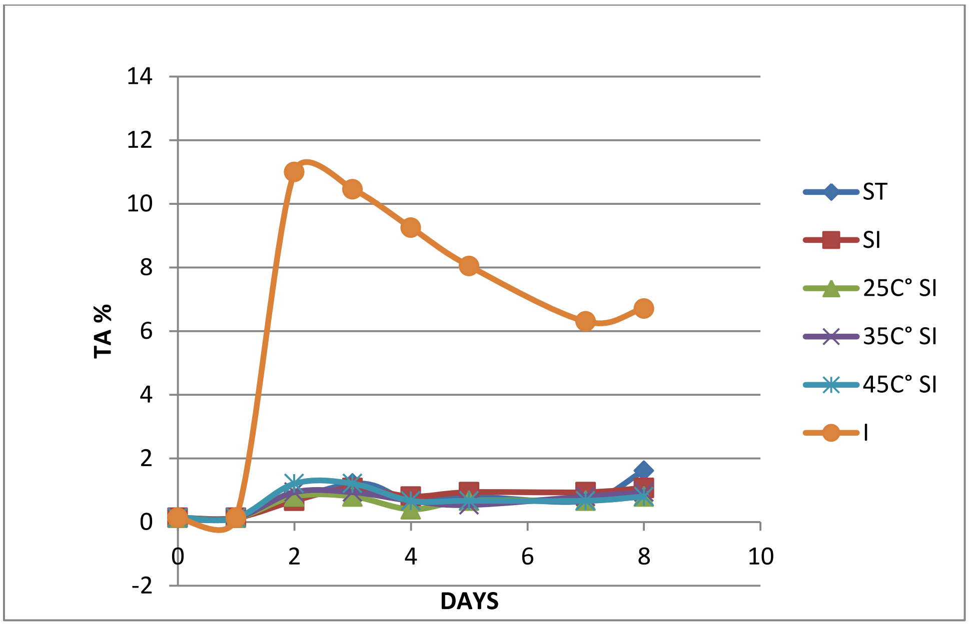


Figure 4.13. Plot of acidity change versus production days

Some authors expressed titratable acidy in other acids such as citric acid (Özgür et al., 2011).

Changes in acidity of isot samples in production processes are shown in Figure 4.13. There was a similar trend in acidity values by time except industrial sample. The higher TA values were determined in the industrial sample. It is a fact that isot production was tried to be simulated at laboratory conditions, some processing parameters (such as temperature and pressure) were not enough for the isot formation and less metabolic activity rates at low temperatures compared the real isot production.

Luning et al. (1995) investigated the influence of hot-air drying on the composition of both volatile and non-volatile flavour compounds of different Dutch bell pepper cultivars. Glucose, ascorbic, fructose, oxalic and citric acid decreased significantly after drying process, while the levels of sucrose, malic, cis-aconiticand fumaricacid increased. Luning et al. (1995) stated thatglucose, fructose and ascorbic acid probably participate in Maillard reactions during heating (drying). These results support our selection for considering malic acid as the predominant acid.

4.9. Capsaicinoid Content

Capsaicin is the main capsaicinoid in peppers, followed by dihydrocapsaicin.and others such as nordihydrocapsaicin, homodihydrocapsaicin and homocapsaicin

The pungency level of capcicum species depends on the concentration of capsainoids; especially capcaicin in the pepper fruit.

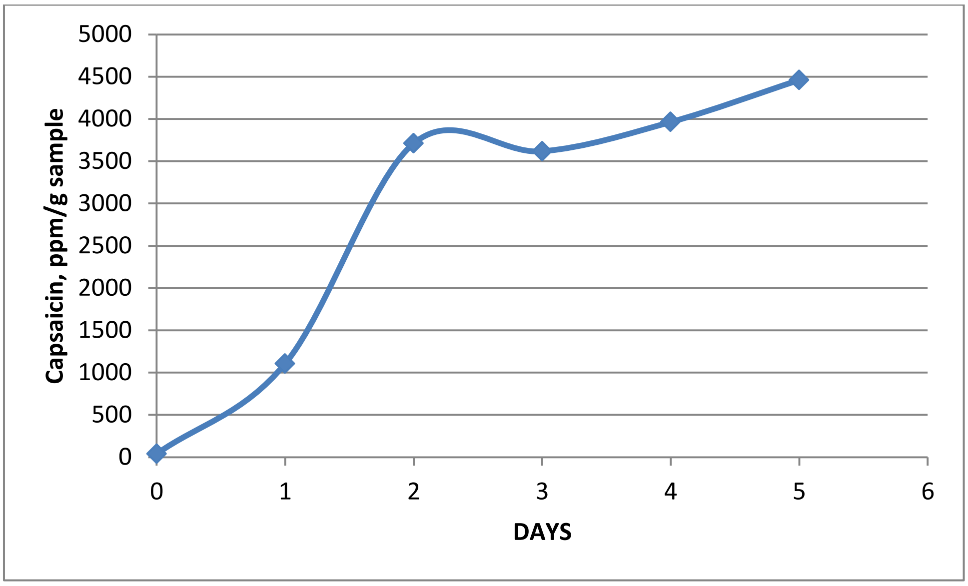


Figure 4.14. Plot of capcaicin change versus production days

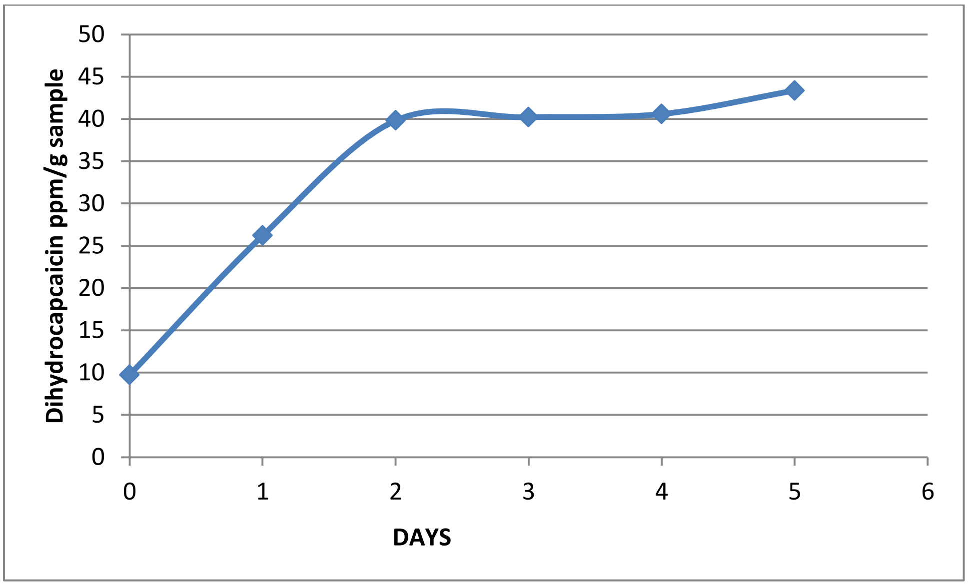


Figure 4.15. Plot of Dihydrocapcaicin change versus production days

The change of capcaicin and dehydrocapcaicin in industrial sample by time were shown in Figure 4.14. and Figure 4.15., respectively and calculated according to datas which are shown in appendix. Firstly there was a significant increase in dihydrocapcaicin amount of industrially produced isot sample during production ($p<0,05$) after that, dihydrocapcaicin values reached a plateau, and stayed almost constant. It could be said that, most metabolic activities have been completed there.

Kurian and Starks (2002) studied quantitative extraction procedure for analysis of capsaicin and dihydrocapsaicin by high-performance liquid chromatographic (HPLC) in whole chili peppers. Relative to dry weight, the orange habañero peppers contained 8840 ppm capsaicin and 3940 ppm dihydrocapsaicin. Our study contained 4459 ppm/ g sample capsaicin and 43.3 ppm/ g sample dihydrocapsaicin.
These dry weight capsaicinoid contents for our samples are much lower than the previously reported (Kurian and Starks (2002)) samples.

CHAPTER V

CONCLUSION

In this study the analyses and relationships of color, acidity, total phenolic content, ascorbic acid, antioxidant content, pH, non-enzymatic browning, and capsaicin content of isot pepper(simulated industrial methods at 25°C,35°C,45°C,open atmosphere conditions, simulated traditional method and industrial sample(taken from factory)) were examined.

- The moisture content of the material was very high during the initial phase of the drying which resulted in high drying rates due to the higher moisture diffusion. Afterwards, moisture content for all samples were almost constant
- In all the conditions there was a decrease in "L*", "a*" and "b*" between the first day and the last day samples significantly ($p<0,05$).
- ASTA color values significantly ($P < 0.05$) changed by drying methods. An increase in ASTA values determined.
- There is an increase in ASTA color values in increasing temperature.
- The industrial sample was shown to have very low antioxidant activity with respect to the other isot samples. Reason of this situation could be the decrease in the metabolic activity of industrial sample
- Antioxidant activity decreased with increasing process temperature when considering the industrially simulated samples by process temperatures.
- There were fluctuations in TPC values of all samples during the production because metabolic activity was going on.
- There is not a significant difference between the initial and final values of TPC ($P>0.05$).
- The industrial isot production process conditions provided better isot formation in quality.
- There were a significant decreases in ascorbic acid during the all production methods ($p<0,05$) and by time.

- There were a significant increase in NEB -absorbance (at 420nm) of isot samples during production ($p<0,05$). Maximum change was in samples produced in factory (industrial) and the minimum change is in sample produced with simulated traditional method.
- There were significant decreases in pH of isot samples during production
- The higher TA% values were determined in the industrial sample by time.
- Changes in titrable acidity of isot samples were more or less the same in all production processes except the industrial sample. Little change in TA was observed.
- For capsaicin and dihydrocapsaicin changes for industrial sample, firstly there was a significant increase and then, the values have reached plateau, and stayed almost constant.

REFERENCES

AOAC (1984). Assoc. Off. Anal.Chem. (AOAC) Official Methods Analysis. Virginia.

Ade-Omowaye, B.I.O., Rastogi, N.K., Angersbach, A., Knorr, D., (2003).Combined effects of pulsed electric field pre-treatment and partial osmotic dehydration on air drying behavior of red bell pepper.*J. Food Eng.***60,** 89–98

Arslan,D.,Özcan,M.M., (2010). Dehydrationofredbell-pepper(*Capsicum annuum* L.): Change in drying behavior, color andantioxidant content. *Food Bioprod Process* doi:10.1016/j.fbp.2010.09.009

Aydin, A., Erkan, E. M., Baskaya, R., & Ciftcioglu, G. (2007). Determination of aflatoxin B1 levels in powdered red pepper. *Food Control*, **18**, 1015–1019.

Bailes M. (1999). The botany of chilli and what it means. In: The fragant chilli. East Roseville, Australia: Kangaroo Pres. 15 p.

Bamdad, F.,Kadivar, M., Keramat, J., (2006). Evaluation of phenolic content and antioxidant activity of Iranian caraway in comparison with cloveand BHT using model systems and vegetable oil.*Int. J. FoodSci. Technol*. **41**, 20–27

Banga, J.R., Balsa-Canto, E., Moles, C.G., Alonso, A.A., (2003).Dynamic optimization of bioreactors—a review.*Proc. Ind. Natl. Sci. Acad*. **69A**, 257–265

Banerjee, M., & Sarkar, P. K. (2003). Microbiological quality of some retail spices in India. *Food Research International*, **36**, 469–474.

Biacs PA, Czinkotai B, Hoschke A. (1992). Factors affecting stability of colored substances in paprika powders.*J Agric Food Chem***40(3)**:363–7.

Buckenhu¨skes, H. J., & Rendlen, M. (2004).Hygienic problems of phytogenic raw materials for food production with special emphasis to herbs and spices.*Food Science and Biotechnology,* **13**, 262-268.

Buttery, R. G., Seifert, R. M., Guadagni, D. G., & Ling, L. C. (1969).Characterization of some volatile constituents of bell pepper.*Journal of Agricultural and Food Chemistry,* **17**, 1322–1327.

Carnevale, J., Cole, E. R., & Crank, G. (1980). Photocatalyzed oxidation of paprika pigments. *Journal of Agricultural and Food Chemistry*, **28**, 953–956.

Collins, M.D., Wasmund, L.M., Bosland, P.W., (1995). Improved method for quantifying capsaicinoids in Capsicum using high performance liquid chromatography.*Horticultural Science***30 (1)**, 137–139.

Crapiste, G. H. (2000). Simulation of drying rates and quality changes during dehydration of foodstuffs. In J. E. Lozano, M. C. Añón, E. Parada Arias, & G. V. Barbosa-Cánovas (Eds.), *Trends in food engineering* (pp. 135–148). Technomic Publishing Co., Inc..

Cremer, D. R., & Eichner, K. (2000). Formation of volatile compounds during heating of spice paprika (*Capsicum annuum*) powder.*Journal of Agricultural and Food Chemistry*, **48**, 2454–2460.

Di Scala K.C., Crapiste G.H., (2008). Drying kinetics and quality changes during drying of redpepper. *LWT Food Sci. Technol*. **41**, 789-795.

Deli, J., Z. Matus, P. Molnárand Gy.Tóth (2001): Separation and identification of carotenoids from different coloured paprika (*Capsicum annuum*) by reversed-phase high performance liquid chromatography. *Eur. Food Res. Technol*. **213** 301-305.

Doymaz, I., Pala, M., (2002). Hot-air drying characteristics of red pepper.*J. Food Eng*. *55*, 331–335.

Doymaz, I.,Tugrul, N., Pala, M., (2006). Drying characteristics of dill and parsley leaves. *J. Food Eng*. **77***,* 559–565.

Erdoğan, A. (2004).The aflatoxin contamination of some pepper types sold in Turkey *Chemosphere,***56**, Issue 4,321–325.

Govindarajan, V. S. (1985): "*Capsicum:* Production, Technology, Chemistry and Quality, Botany, Cultivation, and Primary Processing." *Critical Reviews in Food Science and Nutrition* 22, no. 2 10875.

Guadayol, J. M., Caixach, J., Ribe´, J., Cabanas, J., & Rivera, J. (1997) Extraction, separation and identification of volatile organic compounds from paprika oleoresin (Spanish type). *Journal of Agricultural Food Chemistry*, **45**, 1868–1872.

FAO (2009). Food and Agriculture Organization of the United Nations – Statistics-2008, 2009

Halász-Fekete, M., E. Huhnand P. Záhonyi-Racs: (1984) Tristimulus measurement of ground paprika colour. *Int. Agrophysics* **4** 501-507. 64

Hirayama, O.; Nakamura, K.; Hamada, S.; Kobayashi, Y. (1994). Singlet oxygen quenching ability of naturally occurringcarotenoids. *Lipids*, ***29***, 149-150.

Inyang, U. E.,&Ike, C. I. (1998). Effect of blanching, dehydration method temperature on the ascorbic acid, colour, sliminess and other constituents of okra fruit.*International Journal of Food Sciences and Nutrition*, **49(2),** 125–130.

Ittah, Y., Kanner, J., Granit, R., (1993). Hydrolysis study of carotenoid pigments of paprika (*Capsicum annuum L*. variety Lehava) by HPLC/ photodiode array detection. *Journal of Agricultural and Food Chemistry***41**, 899–901.

Kanner, J., Stella, H., Palevitch, D. & Ben-Gera, I. (1977). Colour retention in sweet red paprika (*Capsicumannuum L*.) powder as affected by moisture contents and ripening stage. *Journal of FoodTechnology*, **12**, 59–64.

Kaymak-Ertekin, F., (2002). Drying and rehydrating kinetics of green and red peppers. *J. Food Sci*. **67**, 168–175.

Kim, S., Park, J., Hwang, I.K., (2004).Composition of main carotenoids in Korean red pepper (*Capsicum annuum L*.) and changes of pigment stablity during the drying and storage process.*Journal of Food Science***69 (1)**, 39–44.

Kim, S.,Lee,K.W.Park,J.,Lee,H.J.,Hwang,I.K.,2006.Effectof dryingin antioxidant activity and changesofascorbic acidand colour by different drying and storage in Korean redpepper(*Capsicum annuum*, L.).*Int.J.FoodSci.Technol*.**41** (Suppl. 1),90–95.

Kiranoudis, C. T., Maroulis, Z. B., Marinos-Kouris, D., & Tsamparlis, M. (1997).Design of tray dryers for food dehydration.*Journal of Food Engineering*, **32**, 269–291.

Klieber, A., & Bagnato, A. (1999). Colour stability of paprika and chili powder. *Food Australia*, **51,** 592–596.

Kurian, A.L.,and Starks, A.N. (2002). HPLC analysisof capsaicinoids extracted from whole orangehabanero chilli Peppers. *Journal of Food Science*.**67(3);**956-962.

Levy, A., Harel, S., Palevitch, D., Akiri, B., Menagem, E., Kanner, J.(1995). Carotenoid pigments and b-carotene in paprika fruits (Capsicum spp.) with different genotypes. *Journal of Agricultural and Food Chemistry***43**, 362–366.

Locey CL, Guzinski JA. (2000). Paprika. In: Lauro GJ,Francis FJ, editors. Natural food colorants. NewYork: Marcel Dekker. p 97–114.

Luning, P. A., de Rijk, T., Wichers, H. J., & Roozen, J. P. (1994).Gas chromatography, mass spectrometry, and sniffing port analyses of volatile compounds of fresh bell peppers (*Capsicum annuum*) at different ripening stages.*Journal of Agricultural Food Chemistry*,**42**, 977–983.

Luning, P. A., de Vries, V. R., Yuksel, D., Ebbenhorst-Seller, T., Wichers,H. J., &Roozen, J. P. (1994). Combined instrumental and sensory evaluation of flavor of fresh bellpepper (*Capsicumannuum*) harvest at three maturation stages.*Journal of Agriculture and Food Chemistry*, **42**, 2855–2861.

Luning, P.A., Ebbenhorst-Seller, T., Rijk1, T., and Roozen, J.P. (1995) Effect of hot-air drying on flavour compounds of bell peppers *(Capsicum annuum*) *Journal of the Science of Food and Agriculture* **68,3**, 355-365.

Marques, L., Prado, M., & Freire, J. (2009).Rehydration characteristics of freeze-dried tropical fruits.*LWT: Food Science and Technology*, **42(7)**, 1232–1237.

Markus, F.,Daood, H.G., Kapitany, J. &Biacs, P.A. (1999). Change in the carotenoid and antioxidant content of spice red pepper(paprika) as a function of ripening and some technological factors. *Journal of Agriculture and Food Chemistry*, **47**, 100–107.

Martinez, S., L. Mercedes, M. Gonzalen-Raurich and A. Bernardo Alvarez (2005). The effects of ripening stage and processing systems on vitamin C content in sweet peppers (*Capsicum annuum* L.). International journal of Food Sciences and Nutrition. 56 (1):45-51.

Midilli, A., Kücük, H., (2003). Mathematical modelling of thin layer drying of pistachio by using solar energy.*Energy Convers. Manage*. **46**, 1667–1679.

Mínguez-Mosquera, M.I., M. Jarén-Galán, J. Garrido-Fernández (1992) Color quality in paprika. *J. Agric. Food Chem*. **40**, 12 2384-2388.

Minguez-Mosquera and Hornero-Mendez, (1994) Comparative study of the effect of paprika processing on the carotenoids in peppers (*Capsicum annuum*) of the Bola and Agridulce varieties .*Journal of Agricultural and Food Chemistry*, **42 (7),** 1555–1560.

Minguez-Mosquera,M.I., Jaren-Galan, M., and Garrido-Fernandez, J. (1994) Competition between the processes of biosynthesis and degradation of carotenoids during the drying of peppers. *Journal of Agricultural and Food Chemistry,* **42 (3),** 645–648.

Nijssen, L. M., Visscher, C. A., Maarse, H., Willemsens, L., & Boelens, M. (1996).Volatile compounds in food. qualitative and quantitative data (Vol. 1). Zeist, The Netherlands: TNO-CIVO Food Analysis Institute.

Osuna-Garcia, J.A. & Wall, M.M. (1997). Prestorage moisture content affects colour loss of round paprika (*Capsicumannuum L.*) understorage. *Journal of Food Quality*, **21**, 251–259.

Osuna-Garcia, J., M.M. Wall and C.A. Waddell: (1997) Natural antioxidants for preventing color loss in stored paprika. *J. Food Sci*. **65**, 5 1017-1021.

Oularbi, S., & Mansouri, B. (1996).Decontamination of black pepper and red pepper by gamma radiation.*Radiation Physics and Chemistry*, 48, 386.

Özgür, M., Özcan,T. Akpinar-Bayizit, A and Yilmaz-Ersan, L. (2011). Functional compounds and antioxidant properties ofdried green and red peppers African Journal of Agricultural Research Vol. 6 (25), pp. 5638-5644,DOI: 10.5897/AJAR11.709.

Park, C.R., Lee, K.J. (1975) A study on influence of drying methods upon the chemical changes in red pepper. Part. 2. Changes of free amino acids, free sugar *Korean J. Nutr*., **8,** pp. 33–37

Perucka,I., Oleszek, W. (2000). Extraction and dtermination of capsaicinoids in fruit of hot pepper capsicum annum L.by spectrophotometry and high-performance liquid chromatography. *J Food Chemistry* **71**, *Issue 2, 287–291*

Peusch, M.,Muller-Seitz, E., Petz, M., Muller, A., Anklam, E., (1997). Extraction of capsaicinoidsfrom chilies (*Capsicumfrutescens L.*) and paprika (*CapsicumannuumL.*) using supercritical fluids and organic solvents.*Zeitschriftfur Lebensmittel-Untersuchungund-Forschung A* **204**, 351–355

Perez-Galvez, A., Jaren-Galan, M., Minguez-Mosquerra, M.I., (2005).Impact of the increased thermal processing on retinol equivalent values of paprika oleoresins.*Journal of Food Engineering* **71 (4)**, 379–385.

Perez-G-Alvez, A., Hornero-Mendez, D., Minguez-Mosquera, M.I., (2005) Dependence of carotenoid content and temperature-time regimes during the traditional slow drying of red pepper for paprika production at La Veracounty.*Eur. Food Res. Technol*. **221**,645–652.

Poyrazoglu, Yemis, O., Çetin Kadakal and Artık, N. (2005) Determination of capsaicinoid profile ofdifferent chilli peppers grown in Turkey.*J Sci Food Agric* **85**:1435–1438

Riva, M., and Peri, C., (1986).Kinetics of Sun and Air-Drying of Different Varieties of Seedless Grapes, *Journal of Food Technology*, **21**, 199-208.

Scala, K.D., Crapiste, G., (2008). Drying kinetics and quality changes during drying of red pepper. *LWT* **41**, 789–795

Senadeera, W., Bhandari, B., Young, G., & Wijesinghe, B. (2000). Physical property changes of fruits and vegetables during hot air drying. In A. S. Mujumdar (Ed.), Drying technology in agriculture and food sciences (pp. 149–166). Enfield (NH), USA: Science Publishers, Inc..

Simal, S., A. Femenia, J.A. Carcel and C. Rossello, (2005).Mathematical modelling of the drying curves of kiwi fruits: Influence of the ripening stage.*J. Sci. Food Agric*., **85**: 425-432.

Singh, R.P.,Murthy, K.N.C., Jayaprakasha, G.K., (2002). Studies on the antioxidant activity of pomegranate (Punicagranatum) peel and seede xtracts using in-vitromodels.*J. Agric. Food Chem*. **50**, 81–86.

Singleton V, Orthofer R andLamuela-Ravento's R, (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. In Methods in Enzymology, Ed by Packer L. Academic Press, Newyork, Pp 152-178

Tannenbaum, S.R. &Young, V.R. (1985).Vitamins and minerals. In: Food Chemistry (edited by O.R. Fennema). Pp. 488–493. NY, USA:MarcelDekker

Tepic A.N., Vujicic B.L. (2004). Colour change in pepper (*Capsicum annuum*) during storage, *Acta Periodica Technologica* ***35***, 59–64,

Topuz, A., and Ozdemir, F.,(2007) Assessment of carotenoids, capsaicinoids and ascorbicacidcomposition of some selectedteppercultivars (*Capsicum annuum L.*) grown in Turkey *J. Food Compos. Anal.*,**20**, pp. 596–602

TÜİK (2011) Turkish Statistical Institute, TÜİK 2011 Spice Report

Tunde-Akintunde,T.Y.,Afolabi,T.J.,Akintunde,B.O.,(2005). Influence of drying methods on drying of bell-pepper (*Capsicum annuum*). *J. Food Eng*. **68**,439–442

Vega-Galvez, A., Lemus-Mondaca, R., Bilbao-Sailnz, C., Fito, P., Andres, A., (2008). Effect of air drying temperature on the quality of rehydrated dried red bell pepper (var. *Lamuyo*). *J. Food Eng*. **85**,42–50.

Vega-Gálvez ,A., Di Scala , K., Rodríguez,K., Lemus-Mondaca, R., Miranda,M., López, J., Perez-Won, M. (2009). Effect of air-drying temperature on physico-chemical properties, antioxidant capacity, colour and total phenolic content of red pepper *(Capsicum annuum, L*. var. Hungarian) *Food Chemistry.* **117** 647–653

Wall, M.M. and P.W. Bosland: (1998) Analytical methods for color and pungency of chiles (capsicums), in Instrumental Methods in Food and Beverage Analysis. Eds. D. Wetzel and G. Charalambous, Elsevier Science B. V.,London pp 347-373.

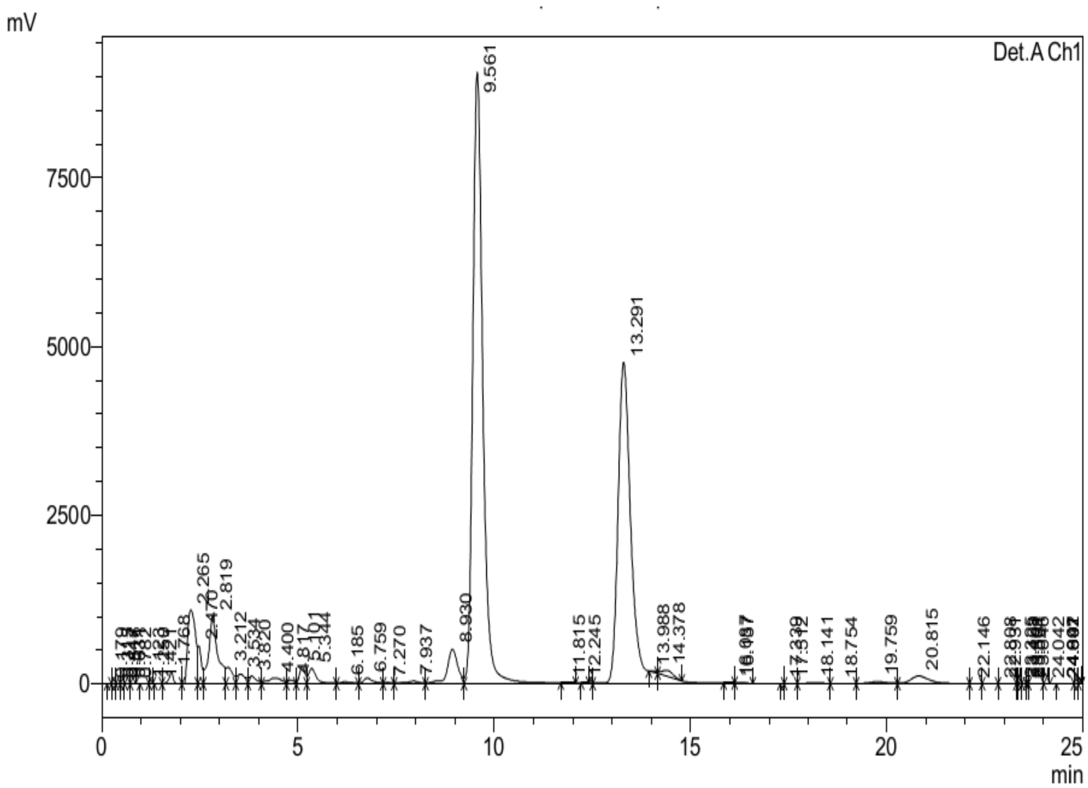
http://www.unctad.info/en/Infocomm/AACP-Products/COMMODITY-PROFILE---Spices/ (28.09.2012)

Yadollahinia, A., Latifi, A., & Mahdavi, R. (2009). New method for determination of potato slice shrinkage during drying. Computers and Electronics in Agriculture, 65, 268–274.

APPENDIX

HPLC RESULTS

Day 0 unknown sample

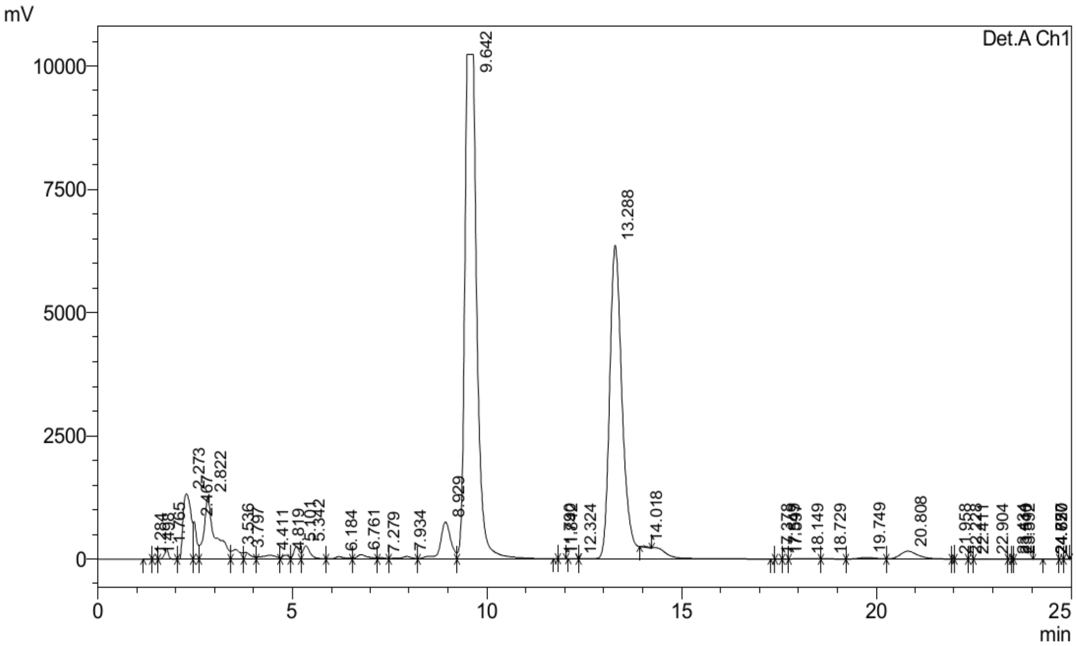


Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.179	1837	406	0.001	0.002
2	0.313	1700	300	0.000	0.002
3	0.447	2176	431	0.001	0.002
4	0.516	2019	359	0.001	0.002
5	0.631	2507	350	0.001	0.002
6	0.782	1591	264	0.000	0.001
7	1.123	2604	358	0.001	0.002
8	1.250	1032	275	0.000	0.001
9	1.421	1557	243	0.000	0.001
10	1.768	1282062	180780	0.371	0.962
11	2.265	15097120	1095692	4.374	5.832
12	2.470	3579404	565815	1.037	3.012
13	2.819	16272256	1011855	4.715	5.386
14	3.212	2691601	243529	0.780	1.296
15	3.534	2152061	143610	0.624	0.764
16	3.820	1574160	113596	0.456	0.605
17	4.400	2206757	88221	0.639	0.470
18	4.817	645972	56891	0.187	0.303
19	5.101	2514969	248334	0.729	1.322
20	5.344	3263916	228567	0.946	1.217
21	6.185	642336	31471	0.186	0.168
22	6.759	1528473	88155	0.443	0.469
23	7.270	257476	18759	0.075	0.100
24	7.937	1040722	39579	0.302	0.211
25	8.930	9571194	513167	2.773	2.731
26	9.561	160466168	9072229	46.495	48.288
27	11.815	20114	1712	0.006	0.009
28	12.245	2142	241	0.001	0.001
29	13.291	113024961	4765360	32.749	25.364
30	13.988	194243	9001	0.056	0.048
31	14.378	1702866	86927	0.493	0.463
32	16.087	18480	2140	0.005	0.011
33	16.137	32258	2311	0.009	0.012

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.339	1250	320	0.000	0.002
35	17.512	9787	751	0.003	0.004
36	18.141	223534	8466	0.065	0.045
37	18.754	79878	2923	0.023	0.016
38	19.759	915308	30919	0.265	0.165
39	20.815	3865825	113819	1.120	0.606
40	22.146	19241	1247	0.006	0.007
41	22.808	43697	3158	0.013	0.017
42	22.931	71633	3779	0.021	0.020
43	23.325	3817	1309	0.001	0.007
44	23.408	6553	1385	0.002	0.007
45	23.501	10957	1719	0.003	0.009
46	23.564	5576	1610	0.002	0.009
47	23.646	23387	1768	0.007	0.009
48	24.042	1878	403	0.001	0.002
49	24.692	37180	2036	0.011	0.011
50	24.807	6564	1129	0.002	0.006
51	24.941	1264	242	0.000	0.001
Total		345126064	18787909	100.000	100.000

Day 1 unknown sample



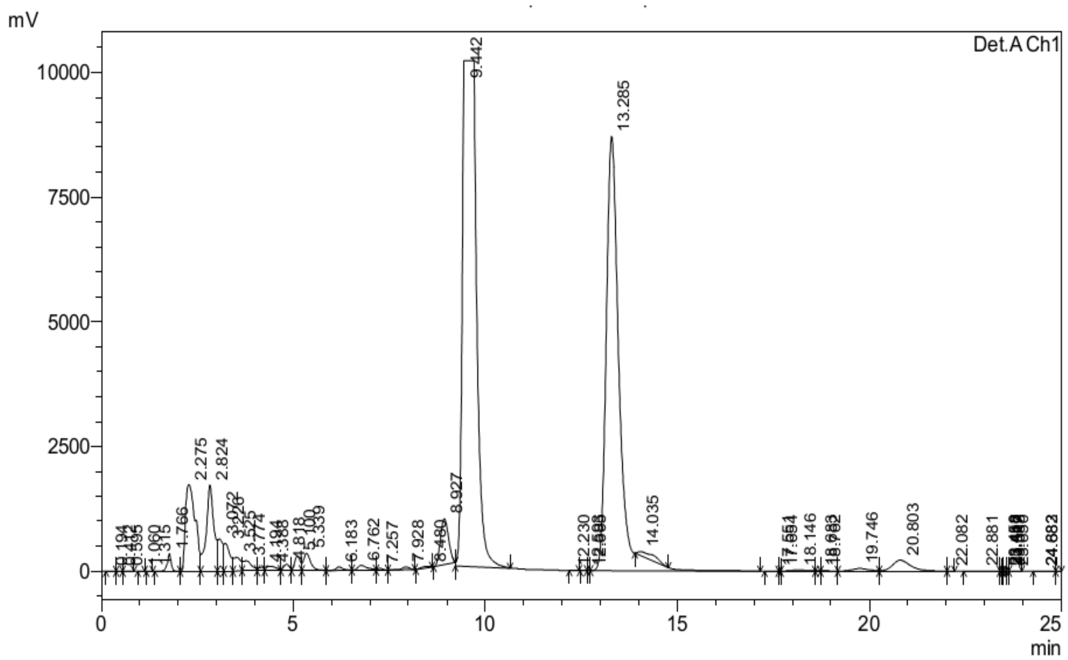
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.284	2758	397	0.001	0.002
2	1.498	2569	401	0.001	0.002
3	1.765	1588052	227669	0.334	1.012
4	2.273	18658797	1330846	3.927	5.913
5	2.467	5014082	767678	1.055	3.411
6	2.822	25284226	1263699	5.321	5.615
7	3.536	3249473	203557	0.684	0.904
8	3.797	1806463	139427	0.380	0.619
9	4.411	2271008	83450	0.478	0.371
10	4.819	996770	89372	0.210	0.397
11	5.101	2618706	260308	0.551	1.157
12	5.342	3880587	276363	0.817	1.228
13	6.184	1157301	55056	0.244	0.245
14	6.761	2000677	99636	0.421	0.443
15	7.279	446596	32758	0.094	0.146
16	7.934	1373208	56049	0.289	0.249
17	8.929	14271083	758795	3.003	3.371
18	9.642	221345950	10239938	46.584	45.496
19	11.790	2552	555	0.001	0.002
20	11.842	3488	655	0.001	0.003
21	12.324	5138	420	0.001	0.002
22	13.288	161755193	6369534	34.042	28.300
23	14.018	224945	16402	0.047	0.073
24	17.378	1607	444	0.000	0.002
25	17.549	7182	826	0.002	0.004
26	17.597	5546	822	0.001	0.004
27	18.149	351699	13187	0.074	0.059
28	18.729	95908	4046	0.020	0.018
29	19.749	1074699	36674	0.226	0.163
30	20.808	5381137	160257	1.132	0.712
31	21.958	7478	1809	0.002	0.008
32	22.228	22534	1182	0.005	0.005
33	22.411	6511	835	0.001	0.004

Peak#	Ret. Time	Area	Height	Area %	Height %
34	22.904	148163	4658	0.031	0.021
35	23.434	8728	1729	0.002	0.008
36	23.510	6350	1670	0.001	0.007
37	23.592	32601	1717	0.007	0.008
38	24.670	32652	2021	0.007	0.009
39	24.757	9447	1507	0.002	0.007
40	24.820	5575	1103	0.001	0.005
Total		475157441	22507451	100.000	100.000

Day 2 unknown sample

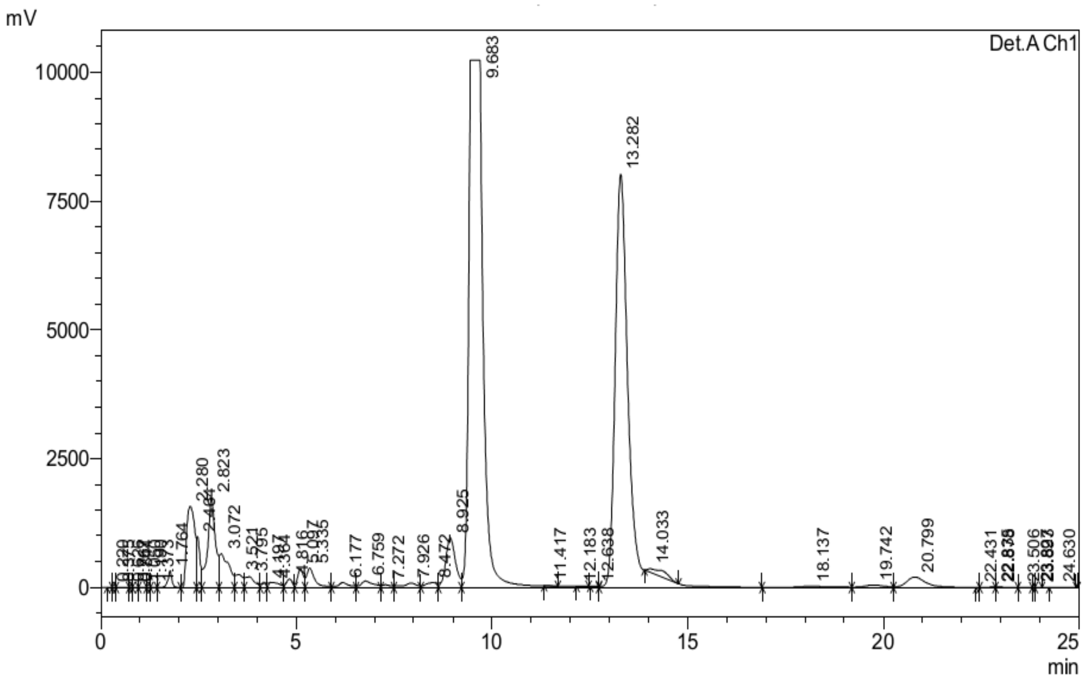


PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.194	4486	450	0.001	0.002
2	0.412	1581	226	0.000	0.001
3	0.595	2019	169	0.000	0.001
4	1.060	1033	284	0.000	0.001
5	1.315	1144	225	0.000	0.001
6	1.766	2392122	353482	0.411	1.315
7	2.275	31102888	1737621	5.345	6.463
8	2.824	23557740	1728918	4.048	6.430
9	3.072	6042846	642851	1.038	2.391
10	3.226	5985315	550763	1.028	2.048
11	3.525	3541633	273386	0.609	1.017
12	3.774	3261644	200333	0.560	0.745
13	4.194	765234	74262	0.131	0.276
14	4.388	1692248	85490	0.291	0.318
15	4.818	1402715	129205	0.241	0.481
16	5.100	2969447	299562	0.510	1.114
17	5.339	4484582	348339	0.771	1.296
18	6.183	898596	68625	0.154	0.255
19	6.762	1793110	100760	0.308	0.375
20	7.257	367489	37192	0.063	0.138
21	7.928	860975	58977	0.148	0.219
22	8.480	456973	23582	0.079	0.088
23	8.927	13511756	923397	2.322	3.434
24	9.442	258598274	10140467	44.436	37.715
25	12.230	5318	565	0.001	0.002
26	12.593	5561	868	0.001	0.003
27	12.665	3510	811	0.001	0.003
28	13.285	204890093	8702826	35.207	32.368
29	14.035	3483296	77228	0.599	0.287
30	17.551	15774	1171	0.003	0.004
31	17.654	2784	863	0.000	0.003
32	18.146	580075	21742	0.100	0.081
33	18.683	45508	5553	0.008	0.021
34	18.762	78789	5581	0.014	0.021
35	19.746	1564681	53244	0.269	0.198
36	20.803	7322493	220276	1.258	0.819
37	22.082	2551	416	0.000	0.002
38	22.881	142314	4955	0.024	0.018
39	23.458	5399	1392	0.001	0.005
40	23.480	2867	1455	0.000	0.005
41	23.517	5859	1475	0.001	0.005
42	23.583	6261	1600	0.001	0.006
43	23.650	15254	1621	0.003	0.006
44	24.683	77181	3304	0.013	0.012
45	24.882	8668	1518	0.001	0.006
Total		581960087	26887029	100.000	100.000

Day 3 unknown sample



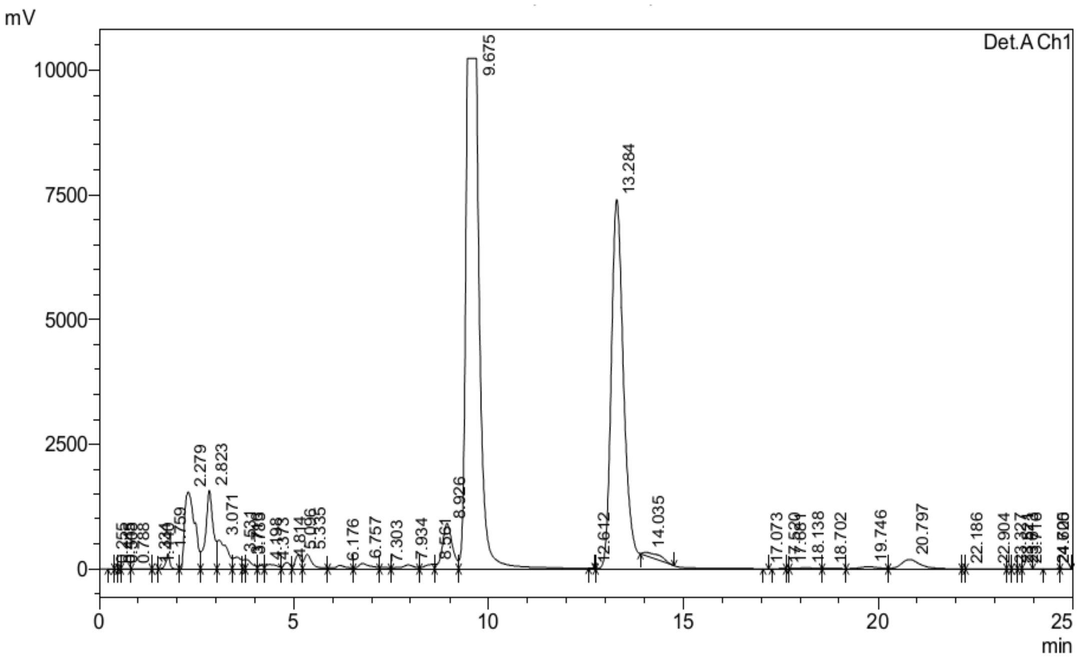
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.220	1284	372	0.000	0.001
2	0.375	1188	337	0.000	0.001
3	0.626	12589	943	0.002	0.004
4	0.767	3817	915	0.001	0.003
5	0.844	9276	982	0.002	0.004
6	1.050	12661	1233	0.002	0.005
7	1.190	6396	1095	0.001	0.004
8	1.373	12653	1389	0.002	0.005
9	1.764	2319196	333534	0.399	1.238
10	2.280	22764622	1576654	3.916	5.854
11	2.464	6156798	988291	1.059	3.670
12	2.823	23786072	1746417	4.092	6.485
13	3.072	11334633	658721	1.950	2.446
14	3.521	3339971	251490	0.575	0.934
15	3.795	3598183	210242	0.619	0.781
16	4.197	912101	86990	0.157	0.323
17	4.364	1948139	95848	0.335	0.356
18	4.816	1924279	164670	0.331	0.611
19	5.097	3766717	365304	0.648	1.356
20	5.335	5586548	377431	0.961	1.401
21	6.177	1960705	97658	0.337	0.363
22	6.759	2840331	127612	0.489	0.474
23	7.272	869596	56483	0.150	0.210
24	7.926	2180308	87581	0.375	0.325
25	8.472	2002304	92474	0.344	0.343
26	8.925	16740872	966764	2.880	3.590
27	9.683	261529198	10240642	44.987	38.024
28	11.417	14988	955	0.003	0.004
29	12.183	6193	269	0.001	0.001
30	12.638	2327	366	0.000	0.001
31	13.282	191661247	8026538	32.968	29.803
32	14.033	3498643	67501	0.602	0.251
33	18.137	1580761	29808	0.272	0.111

Peak#	Ret. Time	Area	Height	Area %	Height %
34	19.742	1747491	53521	0.301	0.199
35	20.799	6949397	204553	1.195	0.760
36	22.431	1209	393	0.000	0.001
37	22.835	67830	5303	0.012	0.020
38	22.878	103170	5256	0.018	0.020
39	23.506	28655	1625	0.005	0.006
40	23.827	2126	611	0.000	0.002
41	23.893	4025	569	0.001	0.002
42	24.630	59314	2553	0.010	0.009
Total		581347812	26931892	100.000	100.000

Day 4 unknown sample

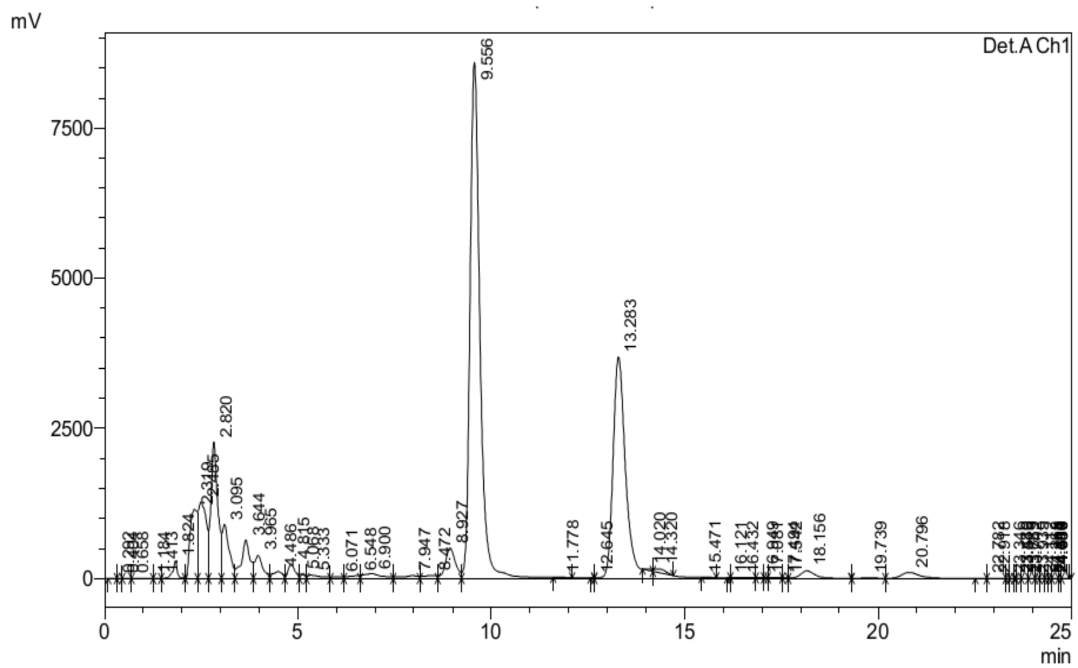


PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.255	1352	230	0.000	0.001
2	0.445	1165	316	0.000	0.001
3	0.508	1150	405	0.000	0.002
4	0.788	9166	1020	0.002	0.004
5	1.334	68070	3376	0.012	0.014
6	1.440	34800	3675	0.006	0.015
7	1.759	2141307	308130	0.393	1.242
8	2.279	28133826	1545903	5.160	6.229
9	2.823	21460556	1577166	3.936	6.355
10	3.071	10443136	583255	1.915	2.350
11	3.531	3386160	242420	0.621	0.977
12	3.716	834502	186187	0.153	0.750
13	3.783	2220686	186809	0.407	0.753
14	4.198	796852	79747	0.146	0.321
15	4.373	1921142	90812	0.352	0.366
16	4.814	1541875	134110	0.283	0.540
17	5.096	2986626	286839	0.548	1.156
18	5.335	4328375	294582	0.794	1.187
19	6.176	1537451	74975	0.282	0.302
20	6.757	2515148	111074	0.461	0.448
21	7.303	554990	40316	0.102	0.162
22	7.934	2034028	81037	0.373	0.327
23	8.561	1597795	90221	0.293	0.364
24	8.926	16089536	912022	2.951	3.675
25	9.675	253534721	10237962	46.497	41.252
26	12.612	2554	439	0.000	0.002
27	13.284	175557982	7406634	32.197	29.843
28	14.035	2911402	60386	0.534	0.243
29	17.073	1228	212	0.000	0.001
30	17.520	16672	1153	0.003	0.005
31	17.681	4306	985	0.001	0.004
32	18.138	493688	18682	0.091	0.075
33	18.702	152129	5681	0.028	0.023
34	19.746	1384037	45913	0.254	0.185
35	20.797	6329816	189436	1.161	0.763
36	22.186	1608	314	0.000	0.001
37	22.904	124273	4457	0.023	0.018
38	23.327	8378	1183	0.002	0.005
39	23.521	13721	1668	0.003	0.007
40	23.613	7987	1436	0.001	0.006
41	23.716	9824	1197	0.002	0.005
42	24.625	50395	3281	0.009	0.013
43	24.700	24280	2695	0.004	0.011
Total		545268694	24818340	100.000	100.000

Day 5 unknown sample



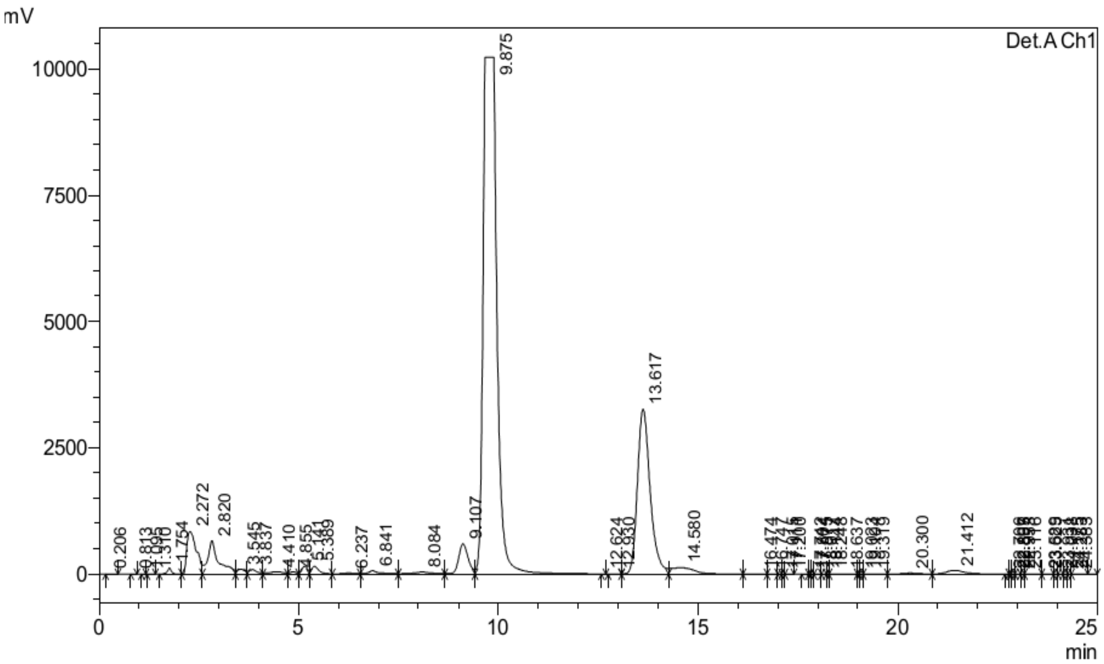
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.292	6959	795	0.002	0.004
2	0.404	7851	1018	0.002	0.005
3	0.658	19405	1811	0.005	0.009
4	1.184	113627	4654	0.031	0.022
5	1.413	59823	5121	0.016	0.025
6	1.824	2371111	296079	0.644	1.420
7	2.319	14449894	1151399	3.927	5.522
8	2.485	18843151	1278596	5.121	6.132
9	2.820	28640007	2276179	7.783	10.916
10	3.095	11299375	905789	3.071	4.344
11	3.644	9806229	640044	2.665	3.070
12	3.965	5485989	385463	1.491	1.849
13	4.486	2079728	117872	0.565	0.565
14	4.815	3097861	235276	0.842	1.128
15	5.068	659909	69892	0.179	0.335
16	5.333	1476388	56861	0.401	0.273
17	6.071	570555	28186	0.155	0.135
18	6.548	1056057	55443	0.287	0.266
19	6.900	2722950	81232	0.740	0.390
20	7.947	1468394	49316	0.399	0.237
21	8.472	1243896	50007	0.338	0.240
22	8.927	9127776	509288	2.481	2.442
23	9.556	153536353	8604202	41.726	41.264
24	11.778	54483	3732	0.015	0.018
25	12.645	1003	230	0.000	0.001
26	13.283	90536866	3693896	24.605	17.715
27	14.020	323352	20653	0.088	0.099
28	14.320	1193840	57930	0.324	0.278
29	15.471	14877	604	0.004	0.003
30	16.121	1092	190	0.000	0.001
31	16.432	59499	2102	0.016	0.010
32	16.949	17730	1607	0.005	0.008
33	17.081	8875	1505	0.002	0.007

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.494	56783	3764	0.015	0.018
35	17.542	38657	3920	0.011	0.019
36	18.156	3296332	124787	0.896	0.598
37	19.739	428525	16868	0.116	0.081
38	20.796	3690328	103224	1.003	0.495
39	22.782	12478	1552	0.003	0.007
40	22.918	34386	1945	0.009	0.009
41	23.346	1308	252	0.000	0.001
42	23.489	3030	543	0.001	0.003
43	23.546	1243	518	0.000	0.002
44	23.669	6376	1038	0.002	0.005
45	23.742	8637	1071	0.002	0.005
46	23.939	5865	757	0.002	0.004
47	24.112	1798	427	0.000	0.002
48	24.268	1721	358	0.000	0.002
49	24.364	2081	468	0.001	0.002
50	24.467	2564	680	0.001	0.003
51	24.614	7365	792	0.002	0.004
52	24.680	4147	821	0.001	0.004
53	24.789	4784	708	0.001	0.003
Total		367963318	20851463	100.000	100.000

Day 0 unknown sample+capsaicin (50ppm)



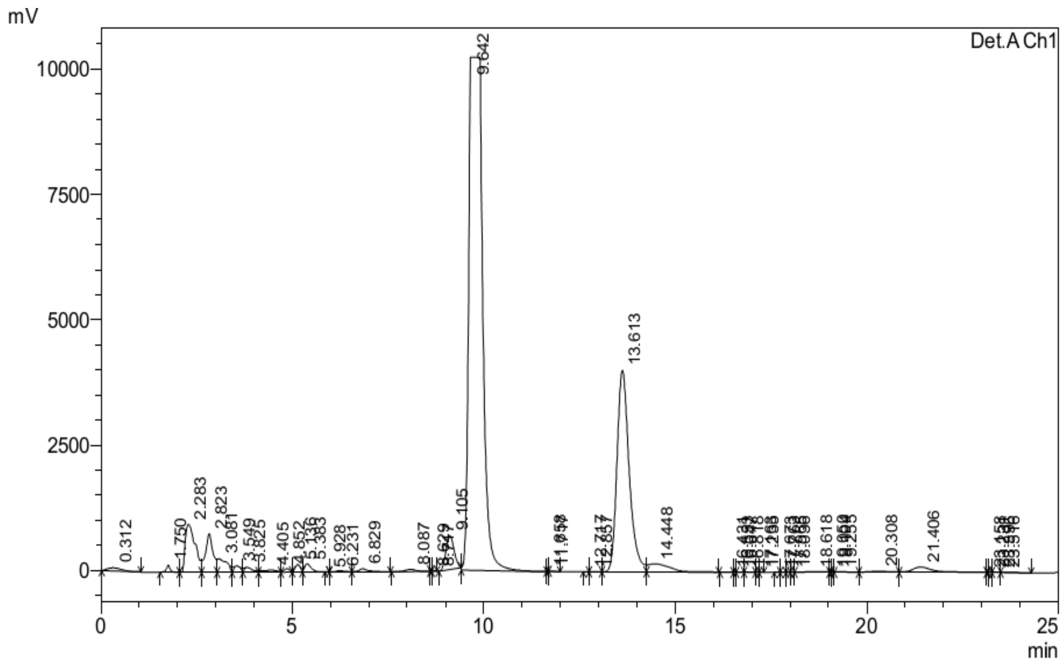
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.206	4576	510	0.001	0.003
2	0.813	1156	132	0.000	0.001
3	1.095	1299	438	0.000	0.003
4	1.310	1619	288	0.000	0.002
5	1.754	833857	123846	0.221	0.739
6	2.272	14296109	843832	3.785	5.034
7	2.820	12723207	660972	3.369	3.943
8	3.545	1363083	98612	0.361	0.588
9	3.837	1331790	89424	0.353	0.534
10	4.410	1260208	50172	0.334	0.299
11	4.855	539239	48769	0.143	0.291
12	5.141	1588497	157333	0.421	0.939
13	5.389	2072998	153609	0.549	0.916
14	6.237	504768	23114	0.134	0.138
15	6.841	1418964	67181	0.376	0.401
16	8.084	1491116	45463	0.395	0.271
17	9.107	10041496	599891	2.659	3.579
18	9.875	245517460	10245135	65.006	61.124
19	12.624	1411	351	0.000	0.002
20	12.930	11301	1076	0.003	0.006
21	13.617	73036288	3275422	19.338	19.542
22	14.580	5546489	131463	1.469	0.784
23	16.474	75620	3456	0.020	0.021
24	16.747	22945	2094	0.006	0.012
25	17.015	4593	878	0.001	0.005
26	17.111	3652	900	0.001	0.005
27	17.200	4691	587	0.001	0.004
28	17.742	3684	539	0.001	0.003
29	17.804	1671	598	0.000	0.004
30	17.875	3663	808	0.001	0.005
31	18.017	8239	962	0.002	0.006
32	18.144	4792	691	0.001	0.004
33	18.248	2981	765	0.001	0.005

Peak#	Ret. Time	Area	Height	Area %	Height %
34	18.637	167089	6448	0.044	0.038
35	19.023	6272	1813	0.002	0.011
36	19.104	11109	1953	0.003	0.012
37	19.319	66317	2691	0.018	0.016
38	20.300	674340	21407	0.179	0.128
39	21.412	2851941	79097	0.755	0.472
40	22.706	1459	308	0.000	0.002
41	22.807	1137	345	0.000	0.002
42	22.855	1413	288	0.000	0.002
43	22.953	2016	300	0.001	0.002
44	23.116	2262	453	0.001	0.003
45	23.589	45248	2793	0.012	0.017
46	23.625	47505	2816	0.013	0.017
47	23.931	17829	2647	0.005	0.016
48	24.038	18705	2607	0.005	0.016
49	24.175	13763	2368	0.004	0.014
50	24.283	11114	1946	0.003	0.012
51	24.383	20759	1727	0.005	0.010
Total		377683742	16761321	100.000	100.000

Day 1 unknown sample+capsaicin (50ppm)



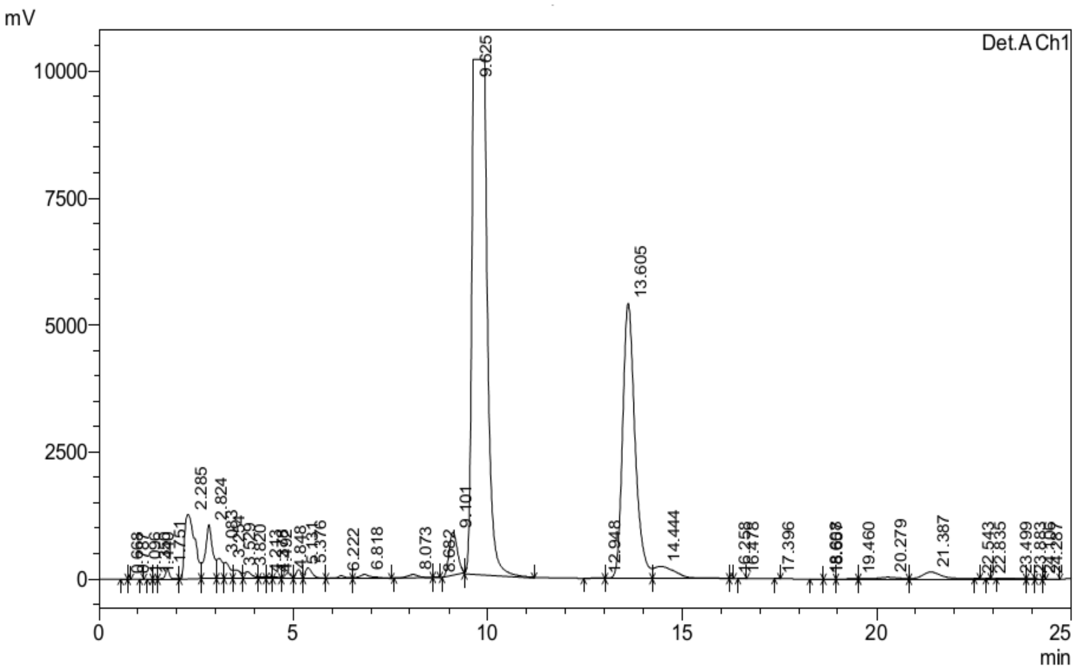
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.312	1647168	61705	0.397	0.338
2	1.750	931453	141466	0.225	0.776
3	2.283	17395012	951177	4.197	5.216
4	2.823	10600799	768904	2.558	4.216
5	3.081	4716227	264843	1.138	1.452
6	3.549	1727363	124722	0.417	0.684
7	3.825	1484624	95418	0.358	0.523
8	4.405	1041738	37852	0.251	0.208
9	4.852	723761	69146	0.175	0.379
10	5.136	1477789	149429	0.357	0.819
11	5.383	2141494	165107	0.517	0.905
12	5.928	3094	605	0.001	0.003
13	6.231	489572	31767	0.118	0.174
14	6.829	1251149	61984	0.302	0.340
15	8.087	1039143	47420	0.251	0.260
16	8.629	3498	1404	0.001	0.008
17	8.717	6257	862	0.002	0.005
18	9.105	9975528	677330	2.407	3.714
19	9.642	256879252	10228080	61.975	56.084
20	11.658	1336	424	0.000	0.002
21	11.717	8365	901	0.002	0.005
22	12.717	3351	673	0.001	0.004
23	12.857	25667	1622	0.006	0.009
24	13.613	89263723	4023842	21.536	22.064
25	14.448	6507368	157369	1.570	0.863
26	16.431	26864	1935	0.006	0.011
27	16.553	8461	2002	0.002	0.011
28	16.647	21679	2041	0.005	0.011
29	16.818	17710	1551	0.004	0.009
30	17.163	2478	541	0.001	0.003
31	17.235	3163	534	0.001	0.003
32	17.673	1074	182	0.000	0.001
33	17.763	1685	256	0.000	0.001

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.965	1138	281	0.000	0.002
35	18.036	1058	271	0.000	0.001
36	18.618	267713	9171	0.065	0.050
37	19.050	14617	4216	0.004	0.023
38	19.104	16557	4217	0.004	0.023
39	19.255	110479	4568	0.027	0.025
40	20.308	723529	23755	0.175	0.130
41	21.406	3676616	104199	0.887	0.571
42	23.158	1595	713	0.000	0.004
43	23.231	8933	1905	0.002	0.010
44	23.396	57142	4748	0.014	0.026
45	23.516	179497	6059	0.043	0.033
Total		414486719	18237197	100.000	100.000

Day 2 unknown sample+capsaicin (50ppm)

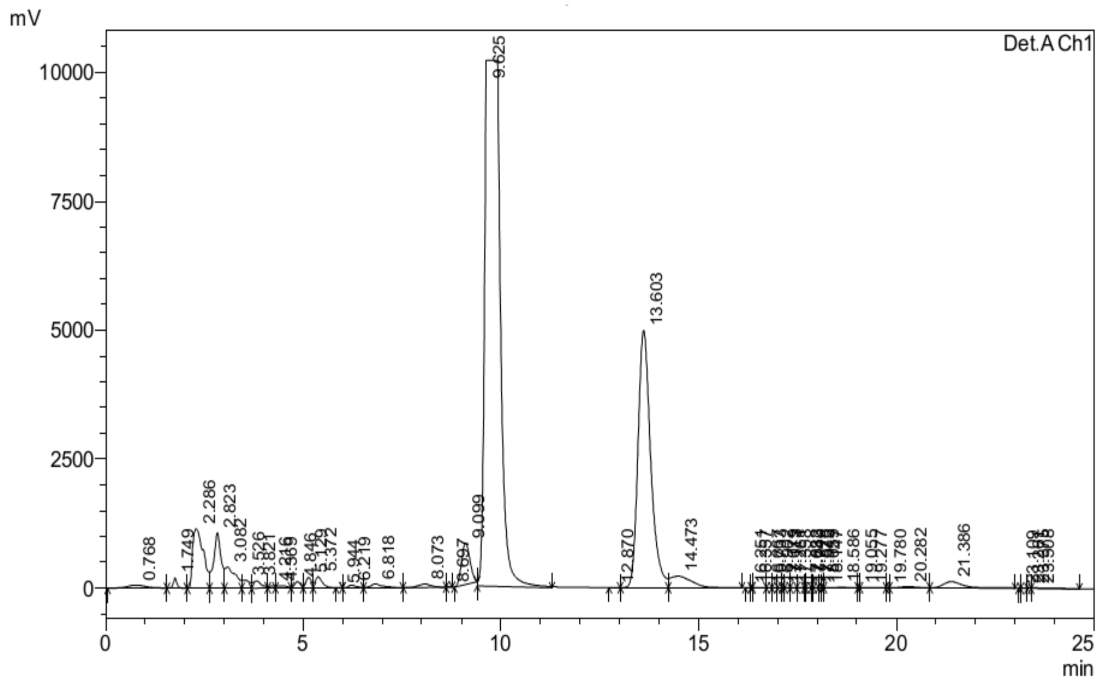


PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.668	2849	509	0.001	0.002
2	0.787	1207	400	0.000	0.002
3	1.096	1836	421	0.000	0.002
4	1.350	1845	248	0.000	0.001
5	1.440	1923	366	0.000	0.002
6	1.751	1411689	218717	0.290	1.027
7	2.285	23637258	1272003	4.857	5.975
8	2.824	14228506	1064697	2.924	5.002
9	3.083	4379130	402694	0.900	1.892
10	3.254	3340316	318735	0.686	1.497
11	3.529	2296036	169797	0.472	0.798
12	3.820	2083224	139025	0.428	0.653
13	4.213	447882	42357	0.092	0.199
14	4.378	409479	42243	0.084	0.198
15	4.492	433570	40172	0.089	0.189
16	4.848	1167477	110781	0.240	0.520
17	5.131	1754731	177472	0.361	0.834
18	5.376	2754890	209859	0.566	0.986
19	6.222	863524	54800	0.177	0.257
20	6.818	1825781	78437	0.375	0.368
21	8.073	1514692	68248	0.311	0.321
22	8.682	12690	1259	0.003	0.006
23	9.101	12395135	842576	2.547	3.958
24	9.625	274691438	10150808	56.445	47.685
25	12.948	73315	4535	0.015	0.021
26	13.605	120255462	5425816	24.711	25.488
27	14.444	9028863	232691	1.855	1.093
28	16.258	1397	364	0.000	0.002
29	16.478	1317	303	0.000	0.001
30	17.396	1183	235	0.000	0.001
31	18.608	84461	7707	0.017	0.036
32	18.657	100299	7679	0.021	0.036
33	19.460	246090	9171	0.051	0.043
34	20.279	1681658	42472	0.346	0.200
35	21.387	5381625	142282	1.106	0.668
36	22.543	1282	263	0.000	0.001
37	22.835	1613	232	0.000	0.001
38	23.499	101748	3325	0.021	0.016
39	23.883	22854	2194	0.005	0.010
40	24.106	8872	1126	0.002	0.005
41	24.287	1127	367	0.000	0.002
Total		486650271	21287386	100.000	100.000

Day 3 unknown sample+capsaicin (50ppm)



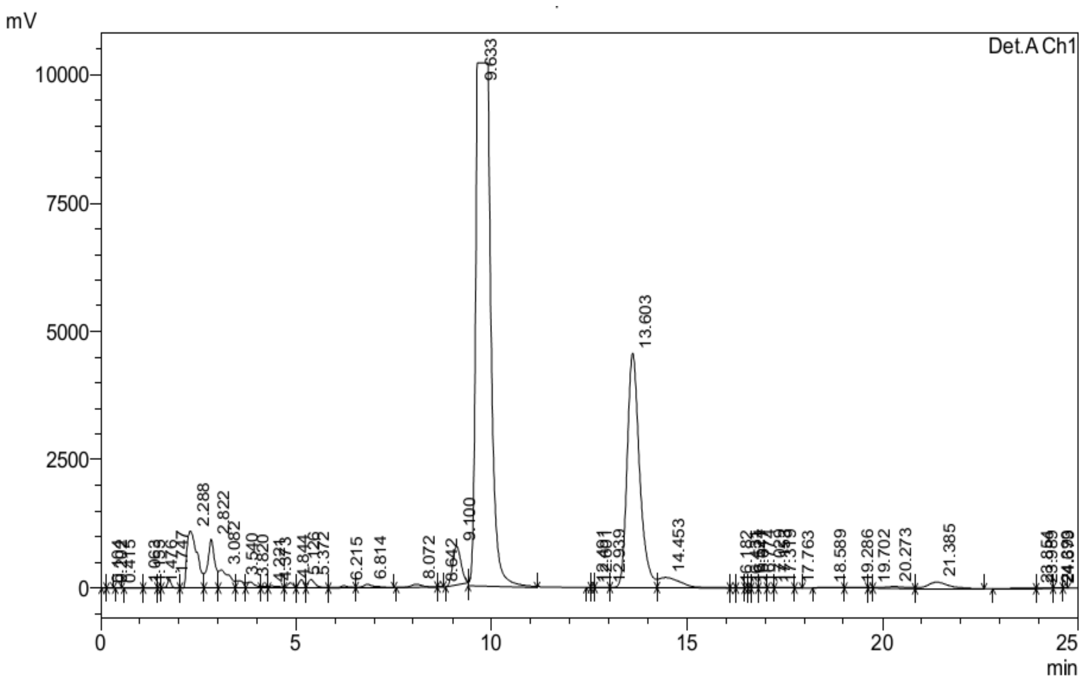
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.768	2076064	61090	0.434	0.299
2	1.749	1294656	202542	0.271	0.991
3	2.286	21957742	1150321	4.589	5.630
4	2.823	14110359	1073097	2.949	5.252
5	3.082	7484262	412687	1.564	2.020
6	3.526	2030411	152484	0.424	0.746
7	3.821	2085244	138794	0.436	0.679
8	4.216	438259	41568	0.092	0.203
9	4.369	801219	42420	0.167	0.208
10	4.846	1275525	120413	0.267	0.589
11	5.129	1998048	200343	0.418	0.981
12	5.372	2817025	212226	0.589	1.039
13	5.944	3167	554	0.001	0.003
14	6.219	810951	54427	0.169	0.266
15	6.818	1674407	75753	0.350	0.371
16	8.073	1515191	65953	0.317	0.323
17	8.697	8353	1164	0.002	0.006
18	9.099	11868203	802311	2.480	3.927
19	9.625	278197455	10196241	58.136	49.905
20	12.870	9685	1056	0.002	0.005
21	13.603	111069176	4988448	23.211	24.416
22	14.473	8596756	220372	1.797	1.079
23	16.251	3109	413	0.001	0.002
24	16.357	1454	699	0.000	0.003
25	16.667	24474	1648	0.005	0.008
26	16.733	12239	1626	0.003	0.008
27	16.902	10945	1514	0.002	0.007
28	17.079	7124	1211	0.001	0.006
29	17.113	5289	1222	0.001	0.006
30	17.261	9648	1382	0.002	0.007
31	17.358	12949	1333	0.003	0.007
32	17.632	14114	1440	0.003	0.007
33	17.683	2657	1339	0.001	0.007

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.740	12801	1411	0.003	0.007
35	17.876	5471	1617	0.001	0.008
36	17.942	10227	1560	0.002	0.008
37	18.059	7942	1514	0.002	0.007
38	18.147	4693	1672	0.001	0.008
39	18.586	368205	12388	0.077	0.061
40	19.055	13414	4543	0.003	0.022
41	19.277	185134	6230	0.039	0.030
42	19.780	12049	2551	0.003	0.012
43	20.282	908359	30270	0.190	0.148
44	21.386	4326388	124976	0.904	0.612
45	23.109	1962	454	0.000	0.002
46	23.261	21751	2715	0.005	0.013
47	23.375	23175	4627	0.005	0.023
48	23.508	397841	6731	0.083	0.033
Total		478525568	20431353	100.000	100.000

Day 4 unknown sample+capsaicin (50ppm)



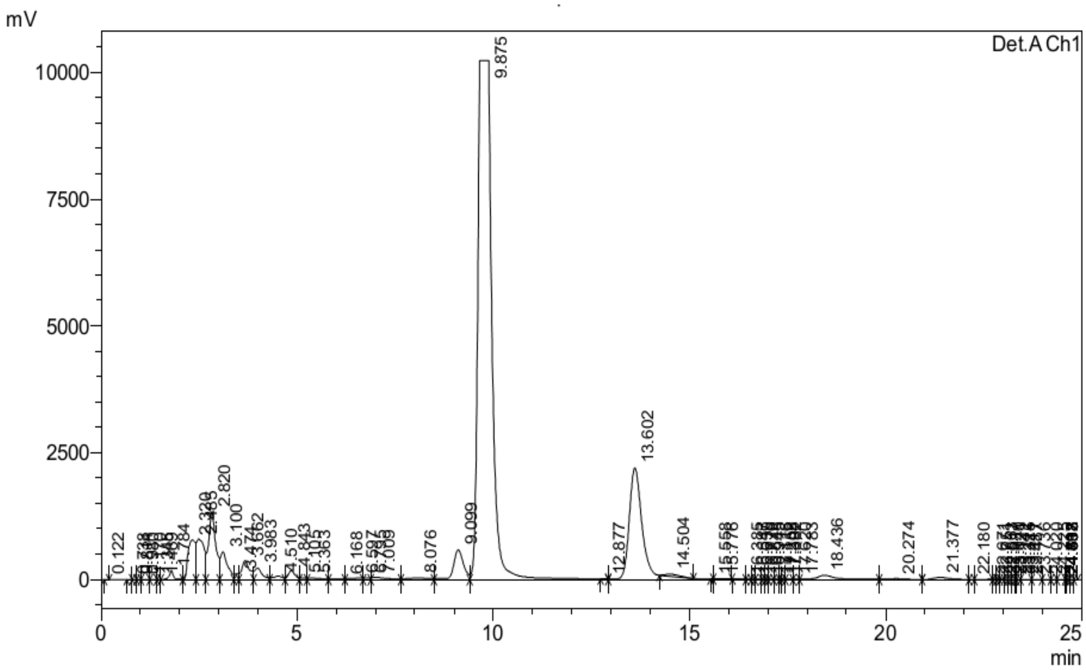
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.104	1542	292	0.000	0.001
2	0.202	1895	385	0.000	0.002
3	0.415	1298	301	0.000	0.002
4	1.063	35549	2512	0.008	0.013
5	1.155	42037	2512	0.009	0.013
6	1.476	3818	761	0.001	0.004
7	1.747	1180818	184941	0.262	0.949
8	2.288	20786318	1107861	4.611	5.687
9	2.822	12304273	950749	2.729	4.880
10	3.082	6625555	356641	1.470	1.831
11	3.540	2066401	141474	0.458	0.726
12	3.820	1736877	119079	0.385	0.611
13	4.221	378392	37525	0.084	0.193
14	4.373	766427	38907	0.170	0.200
15	4.844	1039457	98425	0.231	0.505
16	5.126	1542614	156703	0.342	0.804
17	5.372	2098481	162910	0.465	0.836
18	6.215	599542	40220	0.133	0.206
19	6.814	1432730	66141	0.318	0.340
20	8.072	1340836	60619	0.297	0.311
21	8.642	9855	1876	0.002	0.010
22	9.100	11026538	751598	2.446	3.858
23	9.633	268894790	10192354	59.647	52.320
24	12.491	3058	643	0.001	0.003
25	12.601	5129	1055	0.001	0.005
26	12.939	65527	4022	0.015	0.021
27	13.603	101248880	4571060	22.459	23.464
28	14.453	7899010	200060	1.752	1.027
29	16.182	2275	546	0.001	0.003
30	16.431	8669	985	0.002	0.005
31	16.524	4835	1094	0.001	0.006
32	16.617	6352	1288	0.001	0.007
33	16.774	16039	1781	0.004	0.009

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.029	29977	2855	0.007	0.015
35	17.153	33542	3318	0.007	0.017
36	17.319	74867	3456	0.017	0.018
37	17.763	6246	1038	0.001	0.005
38	18.589	340654	11452	0.076	0.059
39	19.286	253336	7573	0.056	0.039
40	19.702	59098	8030	0.013	0.041
41	20.273	1445447	37375	0.321	0.192
42	21.385	4812828	127354	1.068	0.654
43	23.854	380429	9037	0.084	0.046
44	23.989	161670	7973	0.036	0.041
45	24.393	32223	3432	0.007	0.018
46	24.679	4512	719	0.001	0.004
Total		450810643	19480929	100.000	100.000

Day 5 unknown sample+capsaicin (50ppm)



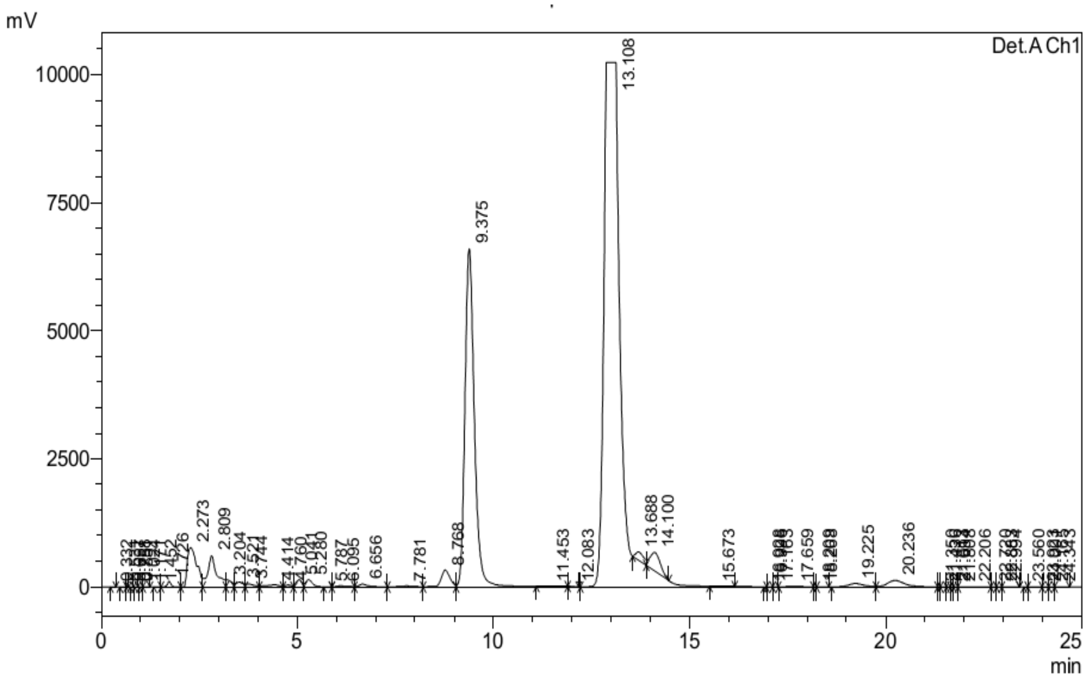
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.122	1602	362	0.000	0.002
2	0.738	2192	437	0.001	0.002
3	0.814	1113	257	0.000	0.001
4	0.980	2573	600	0.001	0.003
5	1.170	6885	701	0.002	0.004
6	1.345	6091	691	0.002	0.004
7	1.469	3908	785	0.001	0.004
8	1.784	1218373	178474	0.314	0.978
9	2.320	10149789	781523	2.615	4.282
10	2.485	10991834	802878	2.832	4.399
11	2.820	17083128	1344567	4.402	7.367
12	3.100	6878613	548633	1.772	3.006
13	3.474	841762	118904	0.217	0.651
14	3.662	5221103	377328	1.345	2.067
15	3.983	3040518	227772	0.783	1.248
16	4.510	1170159	69024	0.301	0.378
17	4.843	2121264	173204	0.547	0.949
18	5.105	380537	38263	0.098	0.210
19	5.363	704564	31672	0.182	0.174
20	6.168	351866	15627	0.091	0.086
21	6.597	732627	36656	0.189	0.201
22	6.795	411050	38749	0.106	0.212
23	7.009	1266581	47047	0.326	0.258
24	8.076	1255856	38331	0.324	0.210
25	9.099	10276085	591815	2.648	3.243
26	9.875	251832074	10244686	64.886	56.133
27	12.877	3022	427	0.001	0.002
28	13.602	54485780	2208172	14.039	12.099
29	14.504	1088011	39123	0.280	0.214
30	15.558	1356	317	0.000	0.002
31	15.776	40326	2456	0.010	0.013
32	16.385	35486	2651	0.009	0.015
33	16.547	25319	3310	0.007	0.018

Peak#	Ret. Time	Area	Height	Area %	Height %
34	16.639	19381	3676	0.005	0.020
35	16.770	40307	4249	0.010	0.023
36	16.848	20278	4086	0.005	0.022
37	16.945	22683	4262	0.006	0.023
38	17.116	36741	4549	0.009	0.025
39	17.252	42380	5315	0.011	0.029
40	17.308	21161	5300	0.005	0.029
41	17.382	24659	5473	0.006	0.030
42	17.620	79497	6886	0.020	0.038
43	17.783	74135	7974	0.019	0.044
44	18.436	3158127	85983	0.814	0.471
45	20.274	737185	19968	0.190	0.109
46	21.377	1532040	49273	0.395	0.270
47	22.180	39443	5060	0.010	0.028
48	22.671	170631	7126	0.044	0.039
49	22.751	37295	6913	0.010	0.038
50	22.863	36174	6604	0.009	0.036
51	22.917	40902	6446	0.011	0.035
52	23.040	32616	6076	0.008	0.033
53	23.121	30518	5746	0.008	0.031
54	23.242	31406	5314	0.008	0.029
55	23.325	12877	5193	0.003	0.028
56	23.411	30720	5217	0.008	0.029
57	23.487	77647	5184	0.020	0.028
58	23.736	58773	4193	0.015	0.023
59	24.020	35384	3143	0.009	0.017
60	24.225	16319	2017	0.004	0.011
61	24.418	15033	1513	0.004	0.008
62	24.592	2613	926	0.001	0.005
63	24.633	2940	816	0.001	0.004
64	24.767	3393	567	0.001	0.003
65	24.838	2060	374	0.001	0.002
Total		388116765	18250864	100.000	100.000

Day 0 unknown sample+dihydrocapsaicin (50ppm)



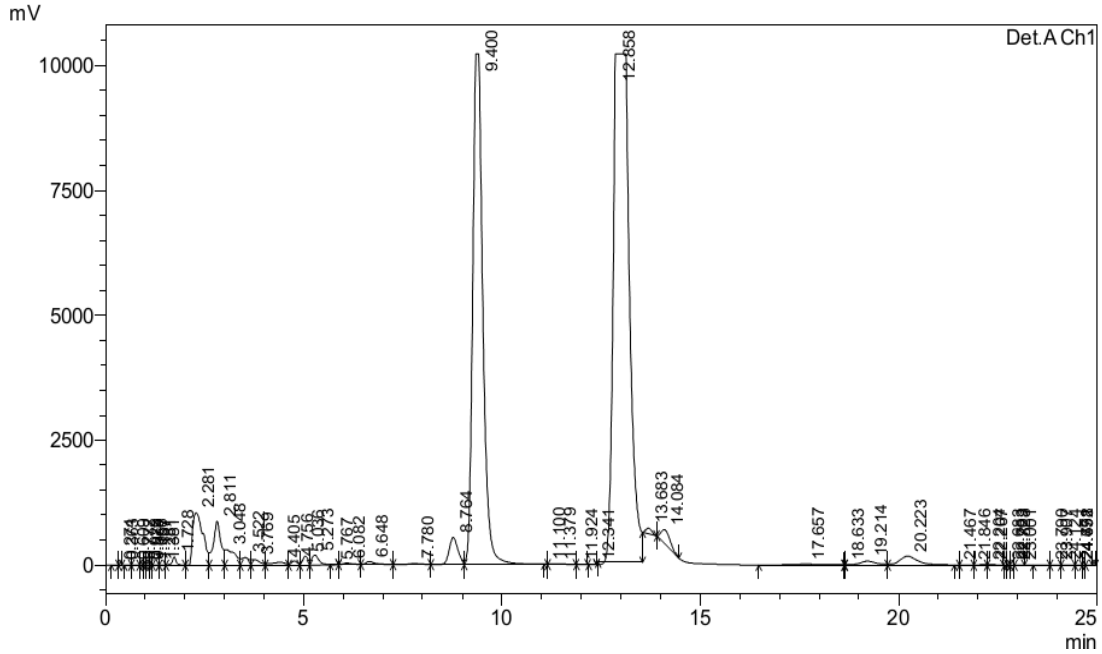
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.332	2022	399	0.000	0.002
2	0.531	2747	370	0.001	0.002
3	0.657	1023	408	0.000	0.002
4	0.758	1117	296	0.000	0.001
5	0.851	1098	264	0.000	0.001
6	1.024	1013	304	0.000	0.002
7	1.171	2028	379	0.000	0.002
8	1.452	4266	608	0.001	0.003
9	1.726	750353	113750	0.158	0.563
10	2.273	13277157	769559	2.804	3.811
11	2.809	9929799	616460	2.097	3.053
12	3.204	1387416	139016	0.293	0.688
13	3.521	1305201	95237	0.276	0.472
14	3.744	946874	59174	0.200	0.293
15	4.414	1095892	46641	0.231	0.231
16	4.760	453410	43370	0.096	0.215
17	5.041	1411520	145617	0.298	0.721
18	5.280	1949047	147338	0.412	0.730
19	5.787	5224	750	0.001	0.004
20	6.095	451665	22417	0.095	0.111
21	6.656	1017814	58825	0.215	0.291
22	7.781	571539	20990	0.121	0.104
23	8.768	5317987	330159	1.123	1.635
24	9.375	110921403	6602710	23.428	32.700
25	11.453	124597	5373	0.026	0.027
26	12.083	2085	178	0.000	0.001
27	13.108	307339272	10240837	64.914	50.717
28	13.688	2288397	147591	0.483	0.731
29	14.100	6529740	355492	1.379	1.761
30	15.673	58370	2410	0.012	0.012
31	16.928	1103	341	0.000	0.002
32	16.996	2634	339	0.001	0.002
33	17.163	1982	259	0.000	0.001

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.659	158681	6498	0.034	0.032
35	18.209	7929	1618	0.002	0.008
36	18.268	15465	1522	0.003	0.008
37	19.225	1867656	66718	0.394	0.330
38	20.236	4000676	127834	0.845	0.633
39	21.350	3695	1071	0.001	0.005
40	21.436	6687	884	0.001	0.004
41	21.613	2794	524	0.001	0.003
42	21.694	2127	496	0.000	0.002
43	21.808	3639	780	0.001	0.004
44	22.206	95013	3134	0.020	0.016
45	22.720	8402	1045	0.002	0.005
46	22.883	8293	1080	0.002	0.005
47	22.994	16891	1144	0.004	0.006
48	23.560	1094	360	0.000	0.002
49	23.923	38259	2737	0.008	0.014
50	24.001	25673	2705	0.005	0.013
51	24.165	18076	2178	0.004	0.011
52	24.343	19956	1742	0.004	0.009
Total		473456802	20191931	100.000	100.000

Day 1 unknown sample+dihydrocapsaicin (50ppm)



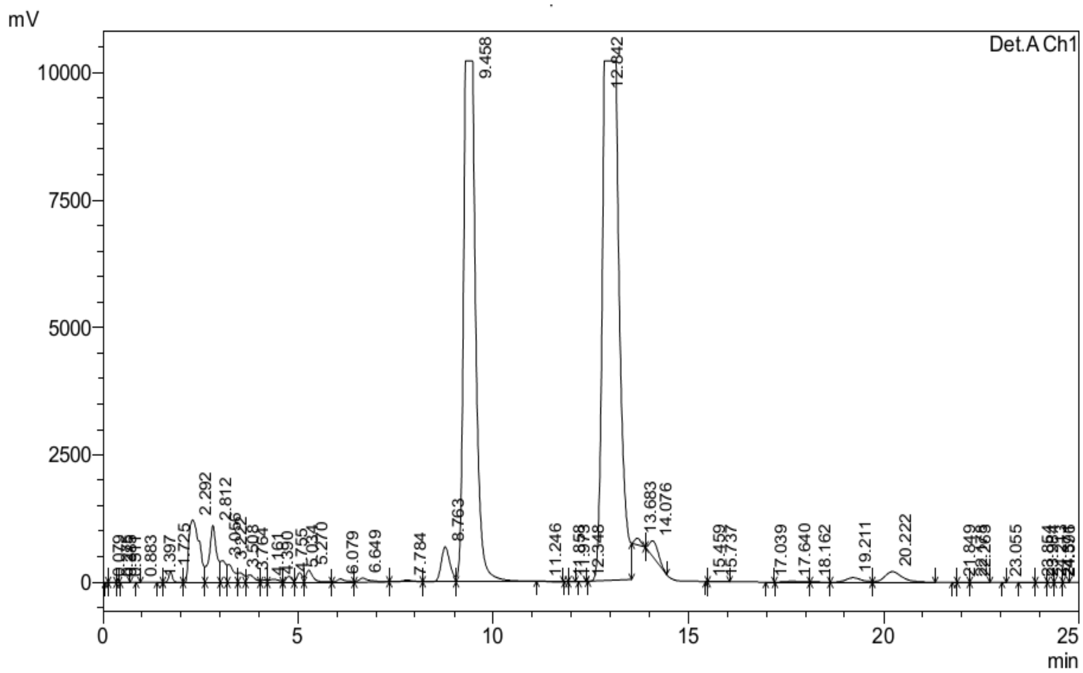
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.274	1773	272	0.000	0.001
2	0.363	1661	455	0.000	0.002
3	0.609	3112	478	0.001	0.002
4	0.772	2854	451	0.001	0.002
5	0.922	2162	638	0.000	0.003
6	0.979	1958	555	0.000	0.002
7	1.066	2841	631	0.001	0.003
8	1.137	2314	624	0.000	0.003
9	1.281	5735	729	0.001	0.003
10	1.381	4208	672	0.001	0.003
11	1.728	1084095	167781	0.199	0.672
12	2.281	19132084	1045029	3.509	4.188
13	2.811	11684554	881704	2.143	3.534
14	3.048	5389656	305739	0.989	1.225
15	3.522	2104030	149733	0.386	0.600
16	3.769	1526828	103471	0.280	0.415
17	4.405	1330923	53204	0.244	0.213
18	4.756	826693	79888	0.152	0.320
19	5.036	1656843	172993	0.304	0.693
20	5.273	2579592	199730	0.473	0.800
21	5.767	2204	463	0.000	0.002
22	6.082	642070	40499	0.118	0.162
23	6.648	1167213	68659	0.214	0.275
24	7.780	582585	28206	0.107	0.113
25	8.764	8532903	547076	1.565	2.193
26	9.400	181609694	10231637	33.312	41.006
27	11.100	2416	497	0.000	0.002
28	11.379	103143	4136	0.019	0.017
29	11.924	5752	386	0.001	0.002
30	12.341	2617	279	0.000	0.001
31	12.858	288806931	10179190	52.975	40.796
32	13.683	1139119	104895	0.209	0.420
33	14.084	4312073	265897	0.791	1.066

Peak#	Ret. Time	Area	Height	Area %	Height %
34	17.657	1503153	24186	0.276	0.097
35	18.633	8886	8894	0.002	0.036
36	19.214	2572875	81374	0.472	0.326
37	20.223	6589811	179821	1.209	0.721
38	21.467	1122	286	0.000	0.001
39	21.846	1216	337	0.000	0.001
40	22.204	41177	3526	0.008	0.014
41	22.267	56236	3549	0.010	0.014
42	22.683	2921	734	0.001	0.003
43	22.763	2396	673	0.000	0.003
44	22.828	3234	647	0.001	0.003
45	23.001	4260	436	0.001	0.002
46	23.790	27823	2491	0.005	0.010
47	23.907	48833	3155	0.009	0.013
48	24.124	44151	2610	0.008	0.010
49	24.478	10609	1332	0.002	0.005
50	24.652	2231	540	0.000	0.002
51	24.791	2575	309	0.000	0.001
Total		545176145	24951497	100.000	100.000

Day 2 unknown sample+dihydrocapsaicin (50ppm)

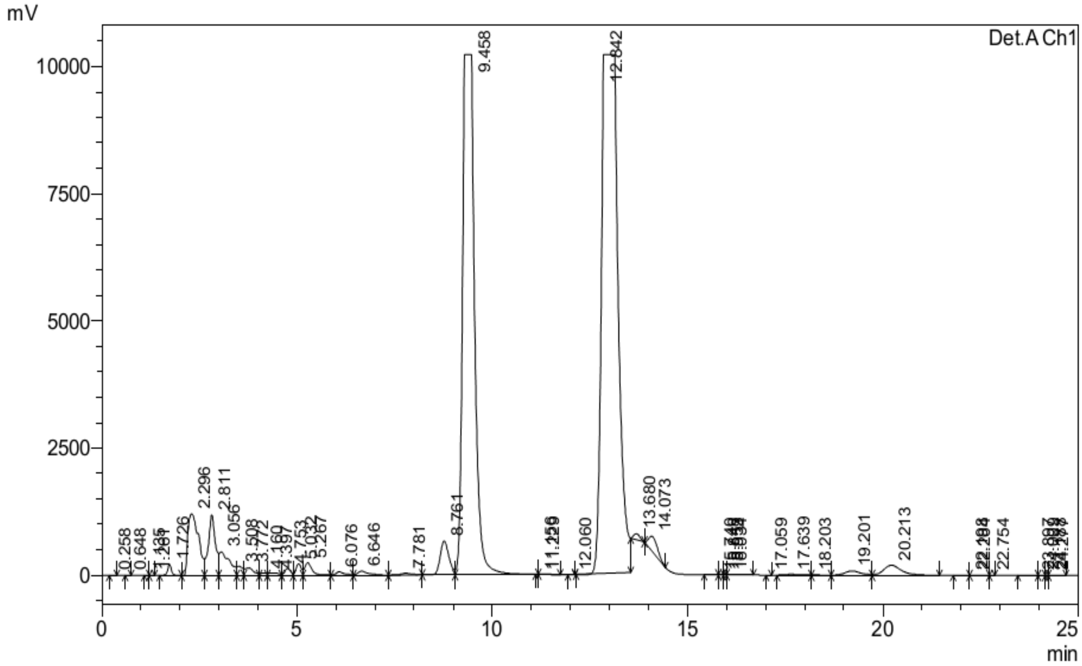


PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.079	1311	374	0.000	0.001
2	0.275	5723	693	0.001	0.003
3	0.385	1574	422	0.000	0.002
4	0.511	6841	746	0.001	0.003
5	0.883	1511	409	0.000	0.002
6	1.397	1181	263	0.000	0.001
7	1.725	1382387	217928	0.224	0.826
8	2.292	22970846	1222304	3.716	4.634
9	2.812	14675001	1116492	2.374	4.233
10	3.056	4338176	428490	0.702	1.625
11	3.222	4088951	349118	0.662	1.324
12	3.508	1961567	184183	0.317	0.698
13	3.764	2120564	140697	0.343	0.533
14	4.161	474636	47377	0.077	0.180
15	4.390	1006010	53246	0.163	0.202
16	4.755	1196238	116201	0.194	0.441
17	5.034	1837858	188581	0.297	0.715
18	5.270	3013651	232760	0.488	0.883
19	6.079	950162	61694	0.154	0.234
20	6.649	1467451	78453	0.237	0.297
21	7.784	760483	41036	0.123	0.156
22	8.763	10768975	689185	1.742	2.613
23	9.458	221497790	10232919	35.836	38.798
24	11.246	43129	1588	0.007	0.006
25	11.858	1387	403	0.000	0.002
26	11.973	2174	350	0.000	0.001
27	12.348	4010	474	0.001	0.002
28	12.842	307514224	10204799	49.753	38.692
29	13.683	1375168	125064	0.222	0.474
30	14.076	4860270	297365	0.786	1.127
31	15.459	1275	448	0.000	0.002
32	15.737	48774	2613	0.008	0.010
33	17.039	2838	316	0.000	0.001
34	17.640	406358	15937	0.066	0.060
35	18.162	67848	3875	0.011	0.015
36	19.211	2462574	87470	0.398	0.332
37	20.222	6493618	208435	1.051	0.790
38	21.849	3712	852	0.001	0.003
39	22.178	49261	3898	0.008	0.015
40	22.263	64797	4106	0.010	0.016
41	23.055	1389	269	0.000	0.001
42	23.854	48703	3616	0.008	0.014
43	23.984	59174	3867	0.010	0.015
44	24.213	22618	2609	0.004	0.010
45	24.371	18908	1884	0.003	0.007
46	24.596	5771	853	0.001	0.003
Total		618086867	26374663	100.000	100.000

Day 3 unknown sample+dihydrocapsaicin (50ppm)



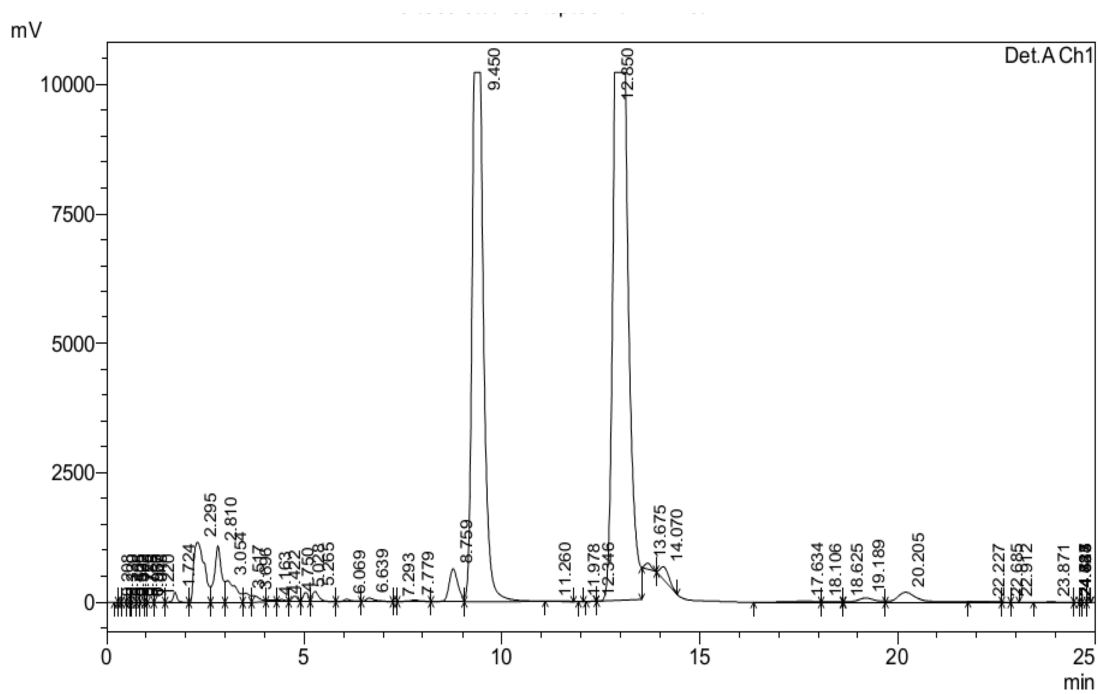
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.258	2534	425	0.000	0.002
2	0.648	1514	298	0.000	0.001
3	1.135	1027	248	0.000	0.001
4	1.261	1216	342	0.000	0.001
5	1.726	1483595	229814	0.243	0.879
6	2.296	23175432	1211381	3.801	4.631
7	2.811	15188962	1195180	2.491	4.569
8	3.056	8577678	463877	1.407	1.773
9	3.508	1817044	173398	0.298	0.663
10	3.772	2285640	146952	0.375	0.562
11	4.160	548098	51515	0.090	0.197
12	4.397	936505	50933	0.154	0.195
13	4.753	1409740	136924	0.231	0.523
14	5.032	2198858	225608	0.361	0.863
15	5.267	3229017	247295	0.530	0.945
16	6.076	1047054	67690	0.172	0.259
17	6.646	1489701	81282	0.244	0.311
18	7.781	765593	40245	0.126	0.154
19	8.761	10514313	669986	1.724	2.561
20	9.458	218699687	10230729	35.867	39.114
21	11.156	2851	1012	0.000	0.004
22	11.229	49842	1946	0.008	0.007
23	12.060	2435	382	0.000	0.001
24	12.842	301071858	10196699	49.376	38.984
25	13.680	1269855	116373	0.208	0.445
26	14.073	4494879	275591	0.737	1.054
27	15.740	51830	4460	0.009	0.017
28	15.848	35867	4932	0.006	0.019
29	15.953	27587	5136	0.005	0.020
30	16.034	119025	5106	0.020	0.020
31	17.059	1877	437	0.000	0.002
32	17.639	375792	14631	0.062	0.056
33	18.203	48283	3201	0.008	0.012

Peak#	Ret. Time	Area	Height	Area %	Height %
34	19.201	2370717	83772	0.389	0.320
35	20.213	6221165	199542	1.020	0.763
36	22.198	47231	3465	0.008	0.013
37	22.264	49723	3494	0.008	0.013
38	22.754	1369	360	0.000	0.001
39	23.897	62026	3568	0.010	0.014
40	24.009	29703	3192	0.005	0.012
41	24.188	12940	2457	0.002	0.009
42	24.277	30472	2372	0.005	0.009
Total		609750535	26156244	100.000	100.000

Day 4 unknown sample+dihydrocapsaicin (50ppm)



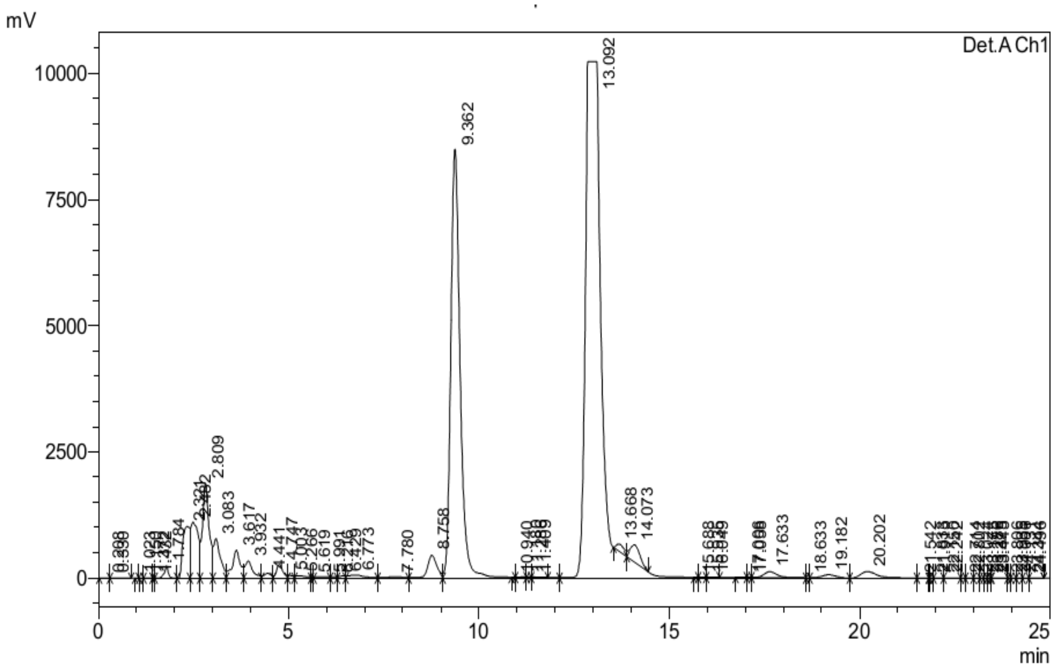
PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.208	2303	437	0.000	0.002
2	0.330	1900	528	0.000	0.002
3	0.456	4949	773	0.001	0.003
4	0.525	3776	814	0.001	0.003
5	0.592	2143	790	0.000	0.003
6	0.720	6224	1091	0.001	0.004
7	0.788	6469	1222	0.001	0.005
8	0.950	7082	1259	0.001	0.005
9	0.967	5041	1252	0.001	0.005
10	1.048	10796	1355	0.002	0.005
11	1.220	7390	817	0.001	0.003
12	1.724	1286847	202017	0.219	0.786
13	2.295	21630384	1156354	3.685	4.500
14	2.810	13827616	1087565	2.356	4.232
15	3.054	7904184	416797	1.347	1.622
16	3.517	1949972	168596	0.332	0.656
17	3.696	1719335	121738	0.293	0.474
18	4.163	652774	46215	0.111	0.180
19	4.422	698084	47458	0.119	0.185
20	4.750	1186319	115708	0.202	0.450
21	5.028	1832688	186114	0.312	0.724
22	5.265	2591594	202122	0.442	0.787
23	6.069	825459	53101	0.141	0.207
24	6.639	1342080	74627	0.229	0.290
25	7.293	2540	544	0.000	0.002
26	7.779	672238	37102	0.115	0.144
27	8.759	9938876	640011	1.693	2.491
28	9.450	211559823	10229970	36.044	39.809
29	11.260	55389	2199	0.009	0.009
30	11.978	1545	362	0.000	0.001
31	12.346	5023	430	0.001	0.002
32	12.850	290227515	10205821	49.447	39.715
33	13.675	1241153	111529	0.211	0.434

Peak#	Ret. Time	Area	Height	Area %	Height %
34	14.070	3696187	232339	0.630	0.904
35	17.634	1341499	28572	0.229	0.111
36	18.106	413617	15391	0.070	0.060
37	18.625	9532	9545	0.002	0.037
38	19.189	2704107	85531	0.461	0.333
39	20.205	7304141	197370	1.244	0.768
40	22.227	119095	4144	0.020	0.016
41	22.685	14110	1221	0.002	0.005
42	22.912	12366	1213	0.002	0.005
43	23.871	112565	3437	0.019	0.013
44	24.485	5235	781	0.001	0.003
45	24.633	1591	507	0.000	0.002
46	24.747	1406	237	0.000	0.001
47	24.824	1502	458	0.000	0.002
Total		586946464	25697462	100.000	100.000

Day 5 unknown sample+dihydrocapsaicin (50ppm)



PeakTable

Detector A Ch1 280nm - 320nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.208	18919	1722	0.003	0.006
2	0.330	29891	1705	0.005	0.006
3	1.023	1638	409	0.000	0.002
4	1.150	2206	418	0.000	0.002
5	1.372	8430	946	0.001	0.004
6	1.432	2435	707	0.000	0.003
7	1.784	1766594	249087	0.311	0.931
8	2.321	13129666	1029148	2.314	3.846
9	2.482	15626598	1114676	2.754	4.165
10	2.809	23150155	1891777	4.080	7.069
11	3.083	9715033	784981	1.712	2.933
12	3.617	8139803	558213	1.435	2.086
13	3.932	4853308	343275	0.855	1.283
14	4.441	1335127	98889	0.235	0.370
15	4.747	3246755	272824	0.572	1.019
16	5.003	574251	60210	0.101	0.225
17	5.266	1006289	53896	0.177	0.201
18	5.619	92414	20594	0.016	0.077
19	5.991	624846	27229	0.110	0.102
20	6.216	294945	29817	0.052	0.111
21	6.429	579522	48473	0.102	0.181
22	6.773	1964046	65376	0.346	0.244
23	7.780	982581	30934	0.173	0.116
24	8.758	7868807	456739	1.387	1.707
25	9.362	145510045	8510283	25.646	31.801
26	10.940	3182	981	0.001	0.004
27	11.180	48964	4293	0.009	0.016
28	11.286	39720	5091	0.007	0.019
29	11.409	84546	5549	0.015	0.021
30	13.092	308578821	10242096	54.387	38.272
31	13.668	2139761	138141	0.377	0.516
32	14.073	6174329	335061	1.088	1.252
33	15.688	1191	286	0.000	0.001

Peak#	Ret. Time	Area	Height	Area %	Height %
34	15.935	10192	1531	0.002	0.006
35	16.049	31569	2272	0.006	0.008
36	17.006	26986	2855	0.005	0.011
37	17.058	22119	3077	0.004	0.011
38	17.633	3132289	123512	0.552	0.462
39	18.633	19061	3496	0.003	0.013
40	19.182	1844372	67775	0.325	0.253
41	20.202	4297102	133951	0.757	0.501
42	21.542	72548	5063	0.013	0.019
43	21.833	5960	3022	0.001	0.011
44	21.915	17532	3420	0.003	0.013
45	22.150	63537	4306	0.011	0.016
46	22.242	77754	4308	0.014	0.016
47	22.714	11370	1607	0.002	0.006
48	22.802	13664	1320	0.002	0.005
49	23.024	11754	1212	0.002	0.005
50	23.175	5589	1036	0.001	0.004
51	23.286	4285	751	0.001	0.003
52	23.375	3184	747	0.001	0.003
53	23.445	1418	735	0.000	0.003
54	23.806	42851	2567	0.008	0.010
55	23.935	11100	2322	0.002	0.009
56	24.006	16358	2165	0.003	0.008
57	24.131	16442	1902	0.003	0.007
58	24.344	13821	1431	0.002	0.005
59	24.496	12419	947	0.002	0.004
Total		567380091	26761161	100.000	100.000

ANOVA RESULTS

Moisture content of ındustrial isot sample

ANOVA

m.c

	Sum of Squares	Df	MeanSquare	F	Sig.
BetweenGroups	9087,158	7	1298,165	625,385	,000
WithinGroups	16,606	8	2,076		
Total	9103,765	15			

ANOVA

asta1

	Sum of Squares	Df	MeanSquare	F	Sig.
BetweenGroups	7701,325	7	1100,189	1,896E3	,000
WithinGroups	4,643	8	,580		
Total	7705,968	15			

ANOVA

dpph1

	Sum of Squares	Df	MeanSquare	F	Sig.
BetweenGroups	1704,076	7	243,439	95,700	,000
WithinGroups	20,350	8	2,544		
Total	1724,426	15			

ANOVA

t.p.c

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	1,146	7	,164	2,052E3	,000
WithinGroups	,001	8	,000		
Total	1,147	15			

ANOVA

n.e.b

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	,939	6	,156	5,477E3	,000
WithinGroups	,000	7	,000		
Total	,939	13			

ANOVA

t.p.c

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	1,146	7	,164	2,052E3	,000
WithinGroups	,001	8	,000		
Total	1,147	15			

ANOVA

vit.c

	Sum of Squares	Df	MeanSquare	F	Sig.
BetweenGroups	,040	7	,006	136,968	,000
WithinGroups	,000	8	,000		
Total	,041	15			

ANOVA

acidity

	Sum of Squares	Df	MeanSquare	F	Sig.
BetweenGroups	253,950	7	36,279	103,633	,000
WithinGroups	2,801	8	,350		
Total	256,751	15			

ANOVA

L

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	310,045	7	44,292	147,460	,000
WithinGroups	2,403	8	,300		
Total	312,448	15			

ANOVA

A

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	1200,843	7	171,549	328,614	,000
WithinGroups	4,176	8	,522		
Total	1205,019	15			

ANOVA

B

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	742,084	7	106,012	124,955	,000
WithinGroups	6,787	8	,848		
Total	748,871	15			

Correlations

		m.c	asta1	dpph1	t.p.c	pH	vit.c	Acidity	L	a	b	n.e.b
m.c	Pearson Correlation	1	-,478	,982**	-,735*	,651	,771*	-,637	,694	,807*	,900**	-,634
	Sig. (2-tailed)		,231	,000	,038	,080	,025	,089	,056	,015	,002	,091
	N	8	8	8	8	8	8	8	8	8	8	8
asta1	Pearson Correlation	-,478	1	-,479	,106	-,933**	-,669	,175	-,552	-,815*	-,765*	,239
	Sig. (2-tailed)	,231		,229	,803	,001	,070	,678	,156	,014	,027	,569
	N	8	8	8	8	8	8	8	8	8	8	8
dpph1	Pearson Correlation	,982**	-,479	1	-,824*	,666	,860**	-,749*	,586	,852**	,893**	-,707*
	Sig. (2-tailed)	,000	,229		,012	,071	,006	,032	,127	,007	,003	,050
	N	8	8	8	8	8	8	8	8	8	8	8
t.p.c	Pearson Correlation	-,735*	,106	-,824*	1	-,291	-,766*	,846**	-,143	-,585	-,549	,876**
	Sig. (2-tailed)	,038	,803	,012		,485	,027	,008	,735	,128	,159	,004
	N	8	8	8	8	8	8	8	8	8	8	8
pH	Pearson Correlation	,651	-,933**	,666	-,291	1	,808*	-,378	,619	,926**	,888**	-,321
	Sig. (2-tailed)	,080	,001	,071	,485		,015	,356	,102	,001	,003	,438
	N	8	8	8	8	8	8	8	8	8	8	8
vit.c	Pearson Correlation	,771*	-,669	,860**	-,766*	,808*	1	-,810*	,331	,949**	,831*	-,678
	Sig. (2-tailed)	,025	,070	,006	,027	,015		,015	,423	,000	,011	,065
	N	8	8	8	8	8	8	8	8	8	8	8
Acidity	Pearson Correlation	-,637	,175	-,749*	,846**	-,378	-,810*	1	,062	-,672	-,493	,544
	Sig. (2-tailed)	,089	,678	,032	,008	,356	,015		,884	,068	,214	,164
	N	8	8	8	8	8	8	8	8	8	8	8
L	Pearson Correlation	,694	-,552	,586	-,143	,619	,331	,062	1	,528	,793*	-,253
	Sig. (2-tailed)	,056	,156	,127	,735	,102	,423	,884		,178	,019	,546
	N	8	8	8	8	8	8	8	8	8	8	8
a	Pearson Correlation	,807*	-,815*	,852**	-,585	,926**	,949**	-,672	,528	1	,929**	-,507
	Sig. (2-tailed)	,015	,014	,007	,128	,001	,000	,068	,178		,001	,199
	N	8	8	8	8	8	8	8	8	8	8	8
b	Pearson Correlation	,900**	-,765*	,893**	-,549	,888**	,831*	-,493	,793*	,929**	1	-,537
	Sig. (2-tailed)	,002	,027	,003	,159	,003	,011	,214	,019	,001		,170
	N	8	8	8	8	8	8	8	8	8	8	8
n.e.b	Pearson Correlation	-,634	,239	-,707*	,876**	-,321	-,678	,544	-,253	-,507	-,537	1
	Sig. (2-tailed)	,091	,569	,050	,004	,438	,065	,164	,546	,199	,170	
	N	8	8	8	8	8	8	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).