International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

VALORIZATION OF BY-PRODUCTS OF TOMATO CANNING INDUSTRY

AMALOU D., AIT AMMOUR M, AHISHAKIYE BM and AMMOUCHE A.

ABSTRACT

Tomato seeds are the major constituents of the waste processing industry in tomato fruits, they represent 0,5% of the weight of the fruit and contain between 18 – 30% fat. The purpose of this work is the caracterization and extraction tomato seed oil. Tomato seed utilised in this experiment came from a pile waste in storage at the cannery Ammour – Mouzaïa – Algeria. After separation, screening and dry in air, tomato seeds are placed in a device Soxhelet containing n-hexane as extraction solvent. The extraction yield was calculed, it is 209,88grams of oils from 934,06grams seeds, or 22,47%. After, filtration efficiency is 21,47% representing 82% of fat tomato seeds. Physicochemicals properties of the oil quality were measured before and after refining, it appears that refining reduces the acidity of 0,9 to 0, O6%, the chlorophyll content of 15,46 to 0,0092% and causes the disappearance of phosphorus. The result of the chromatographic analysis of the lipid fraction of tomato seed oil showed a chromatographic profil composed of 07 fatty acids from 16 to 18 carbon atoms.The linoleic and oleic acids predominates with 52 and 22% respectively, saturated faty acids are essentially represented by palmitic acid (13,18%) and stearic acid (6,18%). Finaly, the induction time estimated by the Rancimat test, characteristic of stability and resistance of oxidation 4,7 hours at 120°C, corresponding durabiity of 223 days at 20°C.

Keywords: Tomato Seed Oil, Canning Wastes, Fatty Acid Composition, Durability

INTRODUCTION

A tomato is one of the major crops in the world and more especially in the Mediterranean. In Algeria, the production of tomato fruits is 1,094,270 tons, of which 276,000 tons are destined for processing (Anonymous, 2007). This transformation is likely to generate significant amounts of by-products and wastes up to 30 % of the volume to treated fruit. These wastes are represented by peels and especially by the seeds, they are often the cause of technical, economic and environmental and ecological problems. The interest of their valorization is linked both to the global energy crisis, the decline in raw material resources, and finally to the legislation which becomes very severe concerning the nature and environmental protection. Regardless of the energy, compost and seeds, current biotechnology is capable of transforming these waste into organic products sought after by biological industries with a high added value, which can improve on the economic viability of these canneries. Valorization of by-products of tomato fruit processing industry has been the subject of numerous studies. The biochemical composition and nutritional value of tomato seeds was studied by Gad et al (1963); Tsatsaronis and Boskou (1975) and Cantarelli et al (1993). These authors found out that the tomato seeds were essentially comprised of 14.6 to 29, 6 % fats, 14.8 to 41.8% fibers, 2.0 to 9.6% ash, 2, 9 to 5.4 % carbohydrates and 22.9 to 44.8 % proteins. The study of the lipid fraction amounts to Amelotti et al (1967) in Ismail et al (1972) and Lazos et al (1998) showing the predominance of these unsaturated fatty acids (linoleic acid, oleic acid). Recent work on the appreciation of antioxidant power of tomato seed oil was addressed by Knoblich et al (2005), where as Eller et al (2010) evaluated the bioenergetics aptitude of tomato seed oil . The aim of our work is to appreciate the aptitude of tomato seeds to produce edible oil, estimate the extraction efficiency, measure the main constant physicochemical constants of quality and determine the chromatographic profile of lipid fraction.

MATERIAL AND METHODS

Recovery And Seed Preparation

Tomato seeds destined for oil extraction were formed from a pile of 48 Kg tomato residue recovered manually at the tomato paste line of Ammour Mouzaia cannery based in Blida Algeria during the agricultural companion 2009/2010. After drying in the open air for 48 hours followed by sorting, 2715 g of seeds at 6.9% moisture were obtained. Figure 1 describes the processing operation powdered seeds.

Extraction And Oil Refining

Oil was extracted from 40 g tomato powder using a Soxhlet apparatus with 400 ml of n hexane as the solvent for 3 to 4 h at a temperature of about 60°C. The solvent is then evaporated in a rotary evaporator and the crude oil is collected and stored in the Ependorff tubes at a temperature of 165°C until use. Crude oil was then subjected to purification and refining in the refinery CEVITAL group laboratory specialized inedible oils production.

Methods of analysis

The physicochemical characteristics of tomato seed oil such as the iodine index, acid index, saponification index were determined by standard methods adapted by the laboratory of the refinery (IUPAC). The refractive index with an Abbe refractometer, the color using a Lovibond colorimeter titomater, the lycopene content by Adsule (1979) method and the oil oxidation stability by a Rancimat 743. A gas chromatograph of Agile Technology Mark with a flame ionization detector was used to determine and identify the fatty acid profile of extracted and refined oil, with the following operating conditions :

• temperature injector: 200°C

• Temperature sensor : 250°C

• temperature Column: 75 to 200°C

• pressure of the carrier gas : 170 Kpa

• hydrogen gas pressure : 50 kPa

• Amount injected : 1µl

• The profile of fatty acid was determined and quantified using the peak of an internal standard (Chem -Station software).

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

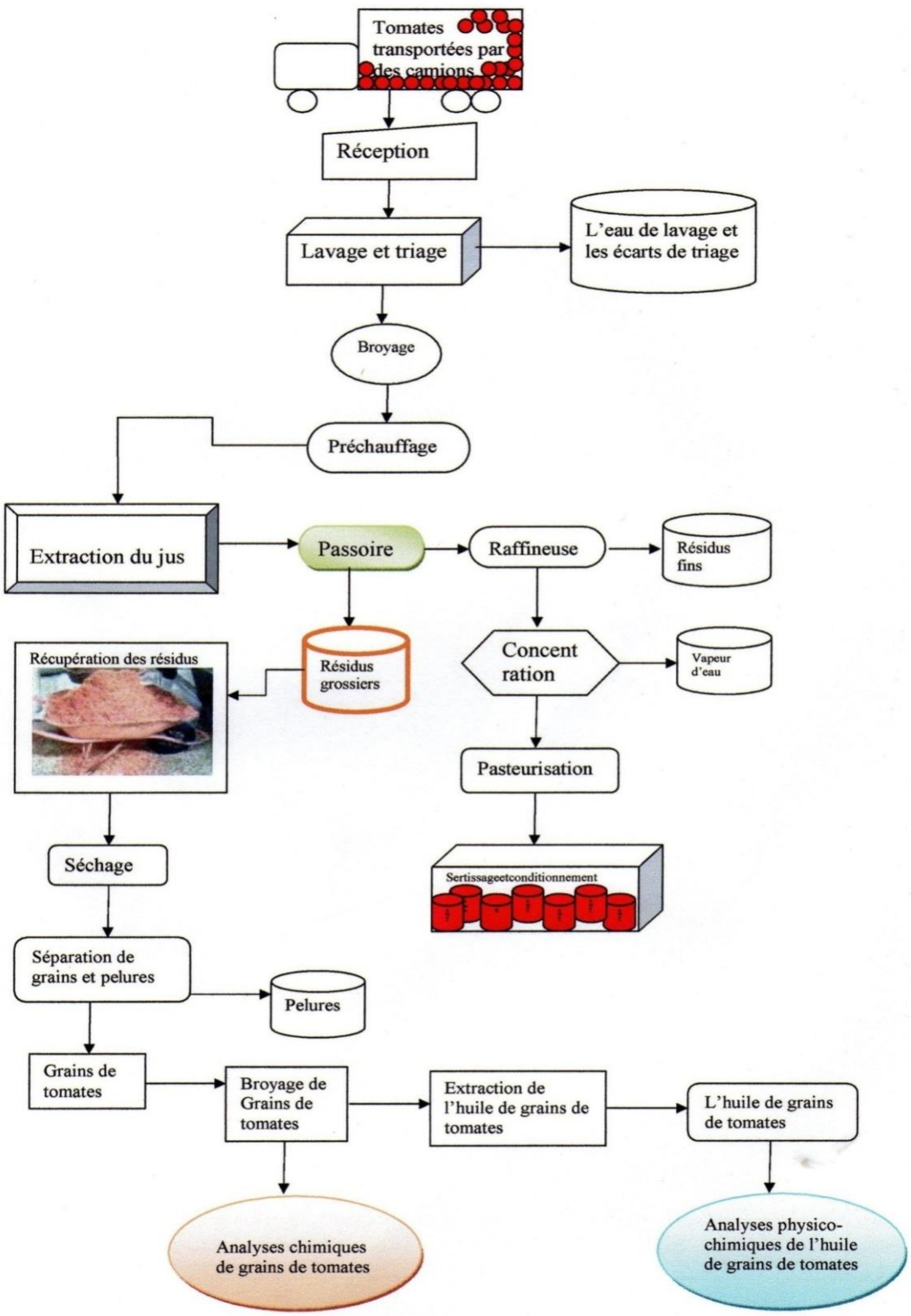


Figure 1. Diagram of recovery and preparation of tomato seeds to oil extraction.

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

RESULTS AND DISCUSSION

The relative distribution of seeds and peels in waste of tomato fruit processing industry shows that it consists of 30% seeds and70% peels. The biochemical composition of peels is dominated by the presence of carotenoïd pigments and lycopene, whereas seed composition is more diversified, this diversity is clearly shown in Table1.

Table 1. The chemical constituents of tomato seed.

Constituents		Quantity
Water	(%)	6,97
Dry matter	(%)	93,03
Ashes	(%)	4,16
Total nitrogen matter	(%)	3,95
Proteins	(%)	24,72
Lipids	(%)	26,2
Total sugars	(%)	4,25
Cellulose	(%)	24,24
Bêta – Carotène	(mg/100g)	1,76
Lycopene	(mg/100g)	2,76

The biochemical composition of tomato seeds is characterized by a dry matter ratio of 93% favorable for direct extraction oil without resorting to a prior drying of tomato seeds. This dry matter rate is very similar to that reported by Cotte (2000) and Knoblich et al (2005), respectively from 92-95% and 88%. On the other hand, the biochemical analysis of tomato seeds revealed their richness in lipid (26.6%), protein (24.72%) and fiber expressed as raw cellulose eqivalent (24.24%). The lipid and fiber content of our tomato seeds is significantly lower than that obtained by Knoblich et al (2005) in the order of 63.7 and 53.79%, without departing from the range of results reported by Abdel-Rahman (1982), Cantarelli et al (1993) and Cotte (2000). All thes authors have recommended the use this type of seeds in animal feed. The other biochemical anayses showed that our tomato seeds have a low lycopene and beta-carorene content compared to those found by Knoblich et al (2005), 130µg/g and 14.4µg/g respectively. In contrast, the ash and sugar expressed as sucrose equivalent is approximate to Abdel-Rahman (1982), Cantarelli et al (1993) and Knoblich et al (2005).

The fat or tomato seed oil varies considerably with the origin of the of the plant material, the adopted method of extraction and the nature of solvent used. The table 2 shown the yields of tomato seeds obtain.

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

Table 2. Résults of yield tomato oil.

M1 (g)	M2 (g)	V1 (ml)	M3 (g)	V2 (ml)	R1 (%)	R2 (%)
934,06	209,86	228,11	201,88	219,43	22,47	21,6

M1 : Quantity of powder of seeds of tomato. M2 : Quantity of unrefined oil. M3 : Quantity of filtred oil.

V1 : Volum of unrefined oil. V2 : Volum of filtred oil

R1 : Yield of unrefined oil. R2 : Yield of oil after filtration

The use of n-hexane as a solvent extraction of polar lipids is encouraged by El- Wandawi et al (1985) and by Cantarelli et al (1993). These authors estimated that the yield of extraction under this cindition is between 14 and 21%, the extraction of non polar lipids requires the use of a second solvent other than n-hexane. The yield of our extraction by reflux for 2 hours in n-hexane is 21.6%, or 82.48% lipids presnt in tomato seeds. This highly aproximates performance obtained by Lazos et al (1998) of about 21.8%, but less than Giannelos et al (2005) yield of the order 31-39%(Table 2).

The Table 3 shown a physico-chemical properties of tomato seed oil and other vegetables oils.

Table 3 : Physicochemical properties of tomato seed oil and others vegetables oils.

Constants	H.T.B	H.T.R	Sunflowers	Soya	Corn	H.O.V
Acidity (%)	0,9	0,06	Max 0,3	Max 0,3	Max 0,3	≤ 2
Index iodine	117	117	118 - 141	124 - 139	103 - 135	75 - 95
I. peroxyde	----	0,4	Max 10	Max 10	Max 10	≤20
I. Saponification	188	188	188 - 194	189 - 195	187 - 195	184 - 196
I. Réfraction	1,467	1,467	1,466-1,470	1,466-1,4670	1,465-1,468	1,4705
Insaponifiable	1,8	1,8	≤15	≤15	≤28	15
Phosphore (ppm)	66	00	00	00	00	--
C. yellow	36	26	Max 10	Max 10	Max 20	--
C. red	6,4	3,2	Max 10	Max 10	Max 2,5	--
Chlorophyll (ppm)	15,46	0,0092	--	--	--	--

H.T.B : Unrefined tomato oil. H.T.R : Refined tomato oil. H.O.V. : Virgin olive oil.

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

This results show that the refining of raw vegetable practiced does not alter the fundamental physici-chemical constants of oil considered. However, some variation of titratable acidity, unsaponifiable content, phosphorus content and somtimes coloring can be observed during degumming operations, neutrlization and bleaching. The refining of our tomato seed oil caused a reduction of 93% in acidity, the removal of phosphorus and the disapearance of chlorophyll . This behavior was also observed by Lazos et al (1998), by Cantarelli et al (1993) and by Giannelos et al (2005).

The fatty acid composition of tomato seed oil extracted is shown in the chromatogram of figure 2 and table 4.

Table 4. Compositon of fatty acids of tomato seed oil and others vegetables oils.

Fatty acids	Formuls	Tomato seed	Sunflowers	Soya	Corn	Olive
Lauric	C12 :0	00	0 - 0,1	0 – 0,1	0 – 0,3	---
Myristic	C14 :0	00	0 – 0,2	0 – 0,2	0 – 0,3	0 – 0,5
Palmitic	C16 :0	13,81	5 – 7,6	8 – 13,5	8,6 – 16,5	7,5 – 20
Palmitoléic	C16 :1	---	0 – 0,3	0 – 0,2	0 – 0,5	0,3 – 3,5
Margaric	C17 :0	---	0 – 0,2	0 – 0,1	0 – 0,1	0 – 0,3
Stearic	C18 :0	6,18	2,7 – 6,5	2 – 5,4	0 – 3,3	0 – 5,5
Oleic	C18 :1	25,52	14 - 39,4	17 - 30	20 – 42,2	55 - 83
Linoleic	C18 :2	52,12	48,3 - 74	48 - 59	34 – 65,6	3,5 – 21
Linolenic	C18 :3	1,90	0 – 0,3	4,5 - 11	0 - 2	---
Arachidic	C20 :0	0,47	0,1 – 0,5	0,1 – 0,6	0,3 – 1,0	0 – 0,6
Gondoïc	C20 :1	00	0 – 0,3	0,1 – 0,5	0,2 – 0,6	0 – 0,4
Behenic	C22 :0	00	0,3 – 1,5	0 – 0,7	0 – 0,5	0 – 0,2
Brassidic	C22 :1	---	0 – 0,3	0 – 0,3	0 – 0,3	---
Linoceric	C24 :0	---	0 – 0,5	0 – 0,5	0 – 0,5	0 – 0,2
Nervonic	C24 :1	---	00	00	00	---

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

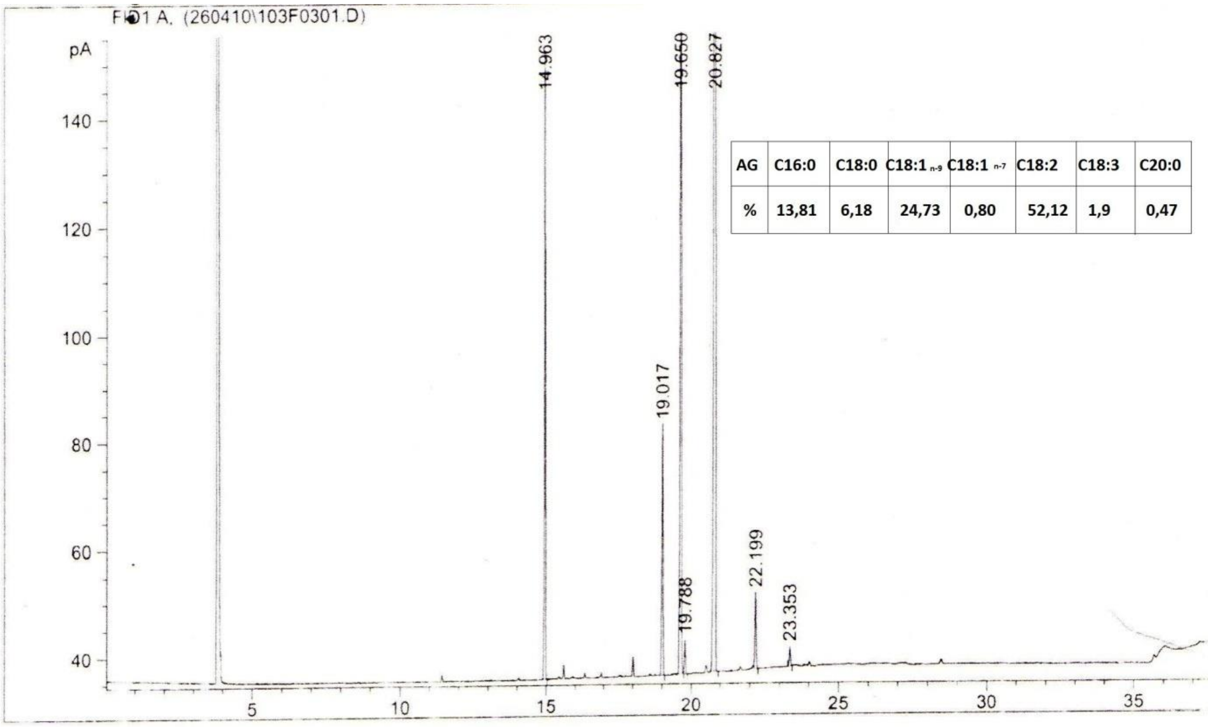


Figure 2 : Chromatogram of fatty acids of tomato seed oil

This analysis identified and quantified three saturated fatty acids, palmitic acid (13.8%), stearic acid (6.18%) and arachidic acid (0.47%), and four unsaturated fatty acids, linoleic acid (52.12%), oleic acid (24.73%), linolenic acid (1.9%) and cis-vaccenic acid (0.80%). This chromatographic profile give a ratio PUFA/AGS as 2.64 indicating the predominance of unsaturated fatty acids (79.55%) responsable for an interesting nutritional and dietary value, it is recommended for flavoring salads, animal feed and can have various industrial applications after hydrogenation. Our results are comparable to those of many authors who identified the same fatty acids, where linoleic acid and palmitic acid are the majority in their respectivecategories (Gad et al.,1968 ; Tsatsaronis and Boskou, 1972 ; Vigo et al., 1977 ; Canella et al., 1979 ; Lazos and Knoblich, 1988 ; Cantarelli et al., 1993). These changes are directly related to the cultivar, conditions of environment, method of extraction and analytical technic used.

The stability of oxidizing oil is determined by the Rancimat test . This test measures the induction time of refined oil at certain temperature time. See the results of this time in a following figures.

International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

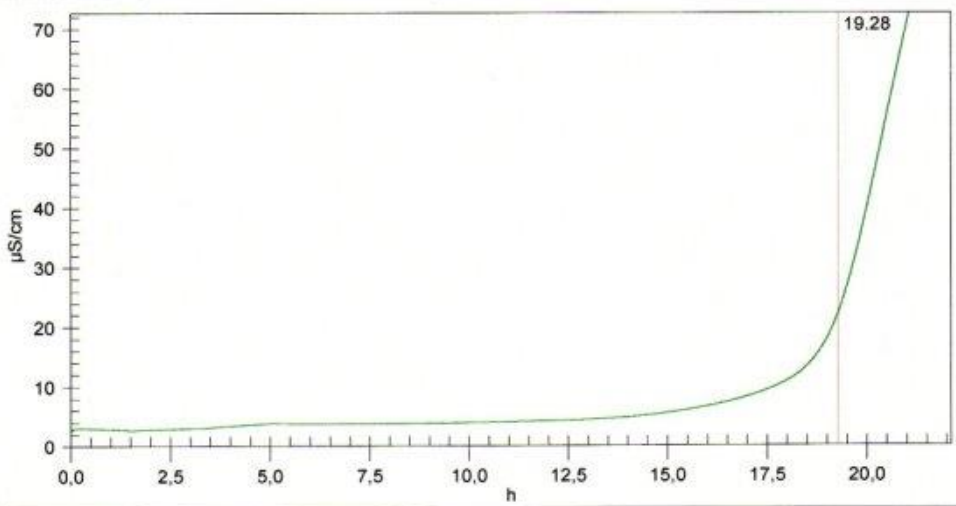
Volume:03, Issue:02 "March-April 2017"

Unit	1	**Serial number**	34132	**Printing date**	26.04.2010 10:03:35
Block	A	**Cell constant**	1	**Determination date**	25.04.2010 12:59:29
Channel	4	**User**	Administrator		

ID 1 Huile de Tomate à 100°C

ID 2 Echantillon du 25/04/2010

Induction time 19,28 h



Method name	HUileTomate à 100°C		
Creator	Administrator	**Creation date**	25.04.2010 12:12:40
Temperature	100 °C	**Stop time**	0,00 h
Delta T	1,60 °C	**Stop at conductivity**	0 µS/cm
Gas flow	20 L/h	**Stop at endpoint**	✓
Start delay	0 min	**Delta Kappa**	0 µS/cm
Start mode	◉ per channel	**Evaluation delay**	0,00 h
	○ per 2 channels	**Evaluation suppression start**	0,00 h
	○ per block	**Evaluation suppression end**	0,00 h
		Evaluation sensitivity	1,00

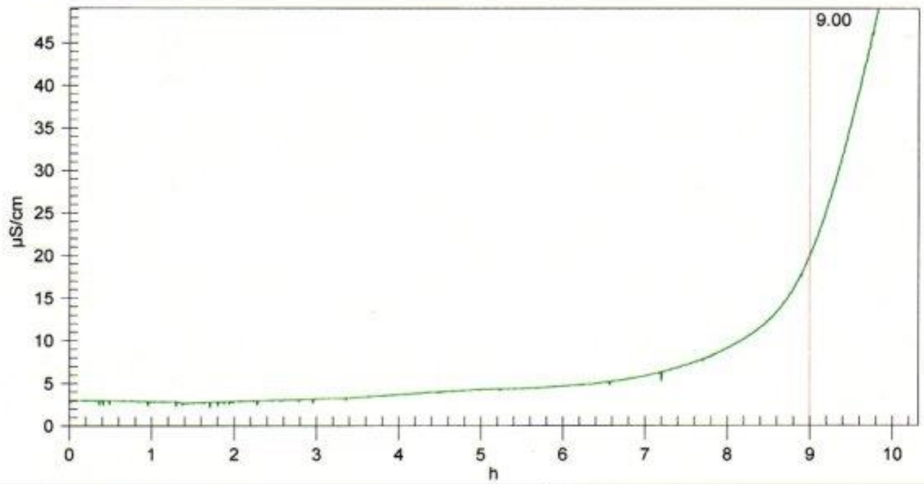
Send to file

Figure 3 : Curve of determination induction time at temperature of 100°C

Unit	1	**Serial number**	34132	**Printing date**	25.04.2010 22:53:05
Block	B	**Cell constant**	1	**Determination date**	25.04.2010 13:03:03
Channel	1	**User**	Administrator		

ID 1	**ID 2**
Huile de Tomate à 110°C	Echantillon du 25/04/2010

Induction time 9,00 h



Method name	Huile Tomate à 110°C		
Creator	Administrator	**Creation date**	25.04.2010 12:12:51
Temperature	110 °C	**Stop time**	0,00 h
Delta T	1,60 °C	**Stop at conductivity**	0 µS/cm
Gas flow	20 L/h	**Stop at endpoint**	✔
Start delay	0 min	**Delta Kappa**	0 µS/cm
Start mode	◉ per channel	**Evaluation delay**	0,00 h
	○ per 2 channels	**Evaluation suppression start**	0,00 h
	○ per block	**Evaluation suppression end**	0,00 h
		Evaluation sensitivity	1,00

Send to file

Figure 4 : Curve of determination of induction time at temperature of 110°C

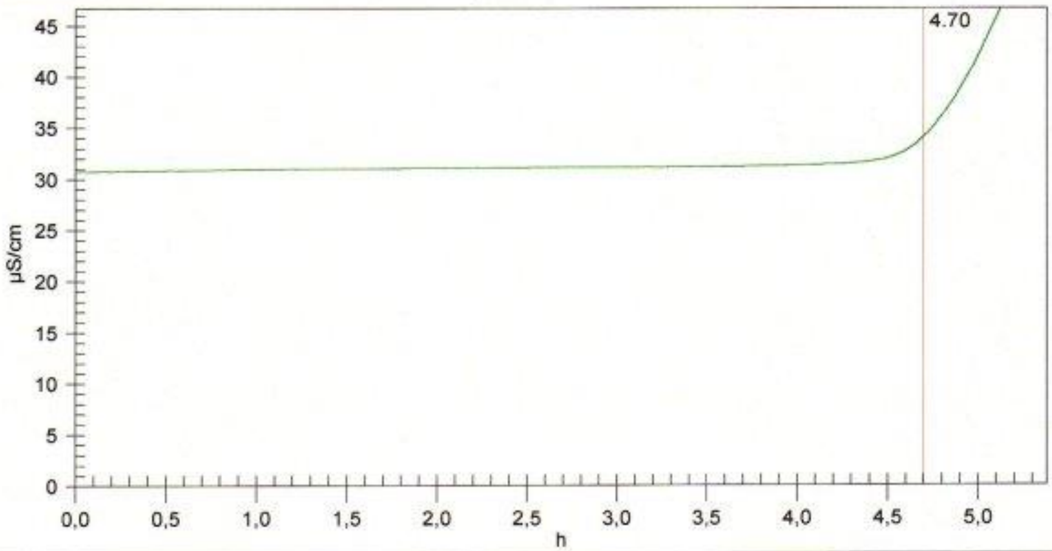
ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

Unit	1	**Serial number**	34132	**Printing date**	26.04.2010 14:55:37
Block	A	**Cell constant**	1	**Determination date**	26.04.2010 09:47:37
Channel	1	**User**	Administrator		

ID 1	**ID 2**
Huile de grains de tomate	à 120°C

Induction time 4,70 h



Method name	huile de grain de tomate à 120 °c		
Creator	Administrator	**Creation date**	26.04.2010 10:29:36
Temperature	120 °C	**Stop time**	0,00 h
Delta T	1,60 °C	**Stop at conductivity**	0 µS/cm
Gas flow	20 L/h	**Stop at endpoint**	✓
Start delay	0 min	**Delta Kappa**	0 µS/cm
Start mode	◉ per channel	**Evaluation delay**	0,00 h
	○ per 2 channels	**Evaluation suppression start**	0,00 h
	○ per block	**Evaluation suppression end**	0,00 h
		Evaluation sensitivity	1,00

Send to file

Figure 5 : Curve of determination of induction time at temperature of 120°C

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

At temperatures of 100, 110 and 120°C the induction time is 19.28, 09.00 and 04.70 hours respectively, approximate to the induction time of 04.85 hours measured at 120°C reported by Lazos et al (1998). The last figure represents the extrapolation of the induction time for the temperature of 20°C. At this temperature, the durability of tomato seed oil extracted is 223 days.

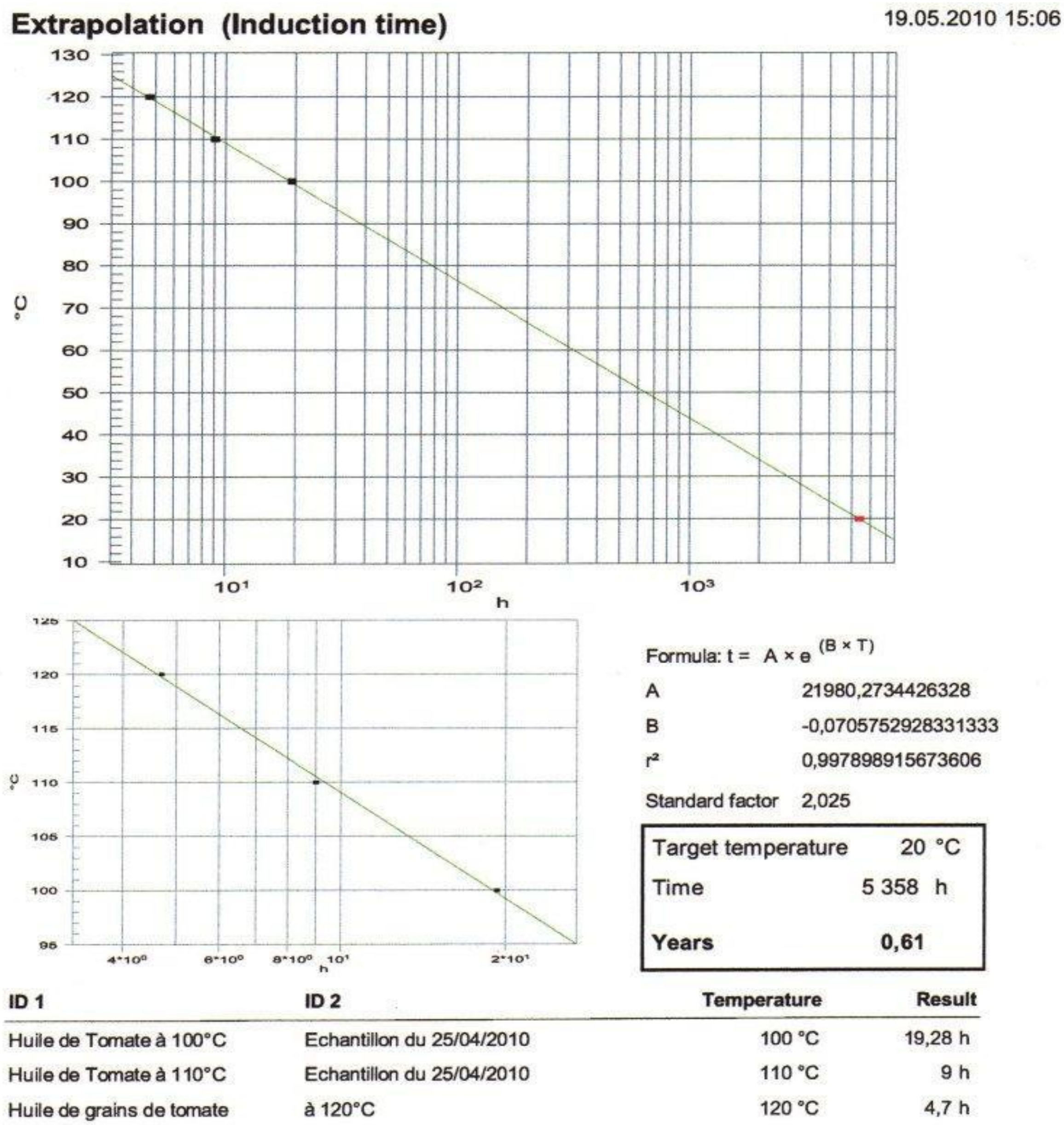


Figure 6. Extrapolation curve of induction time 20°C

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

CONCLUSION

The use of by-products of the food industry is an excellent way of valorization. It provides supplementary added value to farming and processing units, with the possibility of reduccing the costs associated with the removal and disposal of waste. In Algeria, the production of tomato seed oil can reach 1OO tons/year for a volume processing 276 000 tons of tomato fruits on the basis an of extraction yield of 20%. The physico-chemical characterization and determination of chromatographic profile revealed that the tomato seed oil is perfectly edible and nutritionally beneficial to human and animal health, by its richness in unsaturated fatty acids and other elements.

To better understand the mechanisms of action of biomolecules present in this oil and the origin of these health benefits, other research works are necessary, they will be focused on the optimisation of extraction methods, sizing extraction facilities, research and determination of other micro-nutriments and in vivo test on animals and even humans to appreciate the nutritional value and why not the therapeutic value.

REFERENCES

Abdel – Rahman A-H.Y. The chemical constituents of tomato seeds. Food chemistry, 1982 ; 9, p315 – 318.

Adsule Amba Dan PG. Simplified extraction procedure in the rapid spectrophotometric method for lycopene estimation in tomato. J. Food Science and Technology, 1979 ; V16, p216 – 217.

Amelotti G, Garcia V, Federico LG. La composition acidica di aleuni oli vegetali. Rivista Italiana delle Sostanze Grasse, Milano, 1967 ; V44, p372 – 378.

Anonyme, 2007. Bilan de la production de tomate en 2007. Ministère de l'agriculture Algérie.

Bertoni MH, Sutton GK, Cattaneo P. Argentine tomato seed oils ; chemical composition. Annales de l'association quimica Argentina, Buenos Aires, 1983 ; V51, n-2, p144 – 157.

Canella M, Cardinalli JR, Castriotta G, Nappucci R. Chemical properties of the seeds of different tomato varieties. Rivista Italiana delle Sostanze Grasse, Milano, 1979 ; V56, n.1, p8 – 11.

Cotte F. Etude de la valeur alimentaire de pulpe de tomate chez les ruminants. Thèse Docteur vétérinaire, université Lyon 1, 135p, 2000.

ISSN: 2455-6939

Volume:03, Issue:02 "March-April 2017"

Cantarelli PR, Regitano – d'Arce MAB, Palma ER. Physico chemical characteristics and fatty acid composition of tomato seed oils from processing wastes. Sci. Agric, Piracicaba, 1993 ; 50 (1), p117 – 120.

Eller FJ, Moser JK, Kenar JA, Taylor SL. Extraction and analysis of tomato seed oil. J. Am Oil Chem, March 2010.

El Tamimi AH, Morad M, Raof MS, Rady AH. Tomato seed oil. 1 Fatty Acid composition, stability and hydrogenation of the oil. Fette Seifen Anstrichmittel, 1979 ; 81 (7) p281 – 284.

El Wandawi H, Abdul – Rahman M and Al Shaikhly K. Tomato processing wastes as essentiel raw material sources. J. Agric, Food Chem, 1985 ; 33, p804 – 807.

Gad A M, el Khalafy HM, Hassan MM, Shoeb ZE. Chemical investigation on Egyptian vegetal fats and oils. XIII. The chemical constitution of some Rosaceae, Solanaceae and Oleaceae seed oils. Grasas Aceites, 1968 ; 19 (4) 139 6 145.

Giannelos PN, SXIZAS S, Lois E, Zannicas F, Anastopoucous G. Phycall, chemical and fuel related properties of tomato seed oil for evaluating its direct use in diesel engines in industrial crops and products, 2005 ; 22, p193 – 199.

IUPAC. Standard methods for the analysis of oils, fats and derivates. C.Paquat (ed), 7th ed Blackwell Scientific Publications, 1987.

Ismail M, Samwel G, El Azhari KT. Studies on the physical and chemical properties of tomato seed oil. Agric. Res. Rev, 1972, 50 (5), p122 – 125.

Knolich M, Anderson B, Latshaw D. Analyses of tomato peel and seed byproducts and their use as a source of carotenoids. J. Sci. Food Agric, 2005 ; 85 : p1166 – 1170.

Tsatsaronis GC and Boskou DG. Faty acid composition of tomato seed oil. JAOAC, 1972 ; 53, p645 – 647.

Vigo MS, Dasso I, Canttaneo P. Studies on the seeds remaining after the processing of tomatoes. Fisicas y Naturales, 1977 ; V.29, p 193 – 203.

