The Chemistry of the Tomato with Special Reference to the Organic Acids of the Fruit.

by

James Hanson

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Index.

The organic acids of the fruit.

J.F.John in his Chemische Untersuchungen mineralischer, vegetabilischer und animalischer Substanzen, published in 1814, records that the acidity of the juice of the tomato is due to malic acid. His work, however, escaped the attention of the next two investigators in this field, namely of Foderé and Hecht in 1832, and of Landerer in 1839.

Foderé and Hecht in 1832 ascertained the presence of a "peculiar acid" which was not acetic acid and which was destroyed by heat. They concluded that it was in part united with a bitter principle which was probably analogous to solanine. The presence of hydrochloric and sulphuric acids as the salts of potassium was also determined.

In 1839 Landerer observed that the rather bland, but slightly astringent taste of the unripe tomato changes to a pleasant acidulous taste during the process of ripening.

In an article on the medicinal plants of South Carolina, Porcher in 1849 likewise makes the statement that the tomato contains a "peculiar acid".

The occurrence of citric acid in the tomato was first pointed out by Plummer in 1851. Inasmuch as the question as to the identity of the tomato acid has been much controverted, it may not be amiss to quote in full the evidence upon which the conclusions of this invertigator are based.

"The glair of the ripened fruit was subjected to pressure in a clean muslin cloth,and the acid juice obtained was then boiled in a Berlin evaporating dish,to coagulate the albumen present. Of this there was a considerable quantity, but it was easily separable by heat--the acid present no doubt facilitating the process..

"The liquor was then filtered through paper,limpid and colorless. Tested with litmus paper,it proved to be strongly acid. This,indeed,was obvious to the taste.

"This acid liquor was neutralized with ammonia. Both this alkali and potash gave to the liquor a wine-red color, which was discharged by an addition of the tomato juice,or other acid.

"To the neutralized liquor(3)was added chloride of lime. This dissipated the wine-red color,but produced a precipitate. Ebullition in a test-tube,however,for a few moments,yielded a white precipitate. This experiment indicated the absence of oxalic,malic,tartaric and paratararic acids,and the presence of citric acid.

"The white precipitate(4)was soluble in chloride of ammonium. This solution boiled,again yielded a white precipit This reaction with sal-ammoniac afforded another evidence of the absence of paratartaric(racemic)acid.

"The ebullition of 4 was continued until no more precipitate fell. To the decanted liquor,alcohol was added, but the liquid remained clear. This furnished additional evidence of the absence of malic acid.

"The acid juice(2)was neutralized with lime water. No precipitate appeared. On boiling,flocculi were produced,and these were redissolved on cooling. This reaction indicated citric acid,to the exclusion of almost every other organic acid.

"The acid juice(2) was treated with acetate of lead. A very copious,heavy,white precipitate instantly fell. This precipitate was readily soluble in citrate of ammonia; thus again denoting the presence of citric acid.

"To the filtered,neutralized juice,was added sesqui-chloride of iron. The liquid assumed a yellowish-green color, and remained perfectly transparent. The absence of any reaction in this case excludes the idea of tannic,gallic,acetic and benzoic acids being present.

"Thus,then,I determined the certain existence of citric acid in the tomato,and the absence of all other acids."

Bertagnini in 1855 disagreed with the conclusions arrived at by John and stated emphatically that the acid of the green tomato is not malic acid but citric acid.(Expt. evid. not available).

In 1859 Lancaster examined the "red variety" of the tomato.From the juice of one pound of fruit he isolated ten grains of "six sided tables" the taste of which was "somewhat like cream of tartar",but which contained calcium and which,upon incineration gave a residue corresponding in weight with that of "acid malate of lime".He then repeated Plummer's experiments and identified citric acid according to Plummer's method.

Induced by the contradictory reports made by John, who claimed to have found malic acid,and Bertagnini who claimed to have found citric acid,Enz in 1862 undertook to reinvestigate the juice of the red ripe tomato. The mashed tomatoes were set aside in a warm place for three days,the juice expressed and filtered. The filtered juice was boiled to remove albuminous matter and again filtered. The second filtrate served as a basis for a number of qualitative tests. "The addition of lime water produced a faint turbidity and that but gradually. Upon boiling white flocculi separated which disappeared in part upon the addition of sal ammonia.......... After the lime water had caused the separation of a white flocculent precipitate, this was removed by filteration immediately upon cooling and the filtrate heated to boiling. No turbidity resulted, the liquid remained perfectly clear. I could conclude therefrom that the juice contained no citric acid.

(Could the citric acid have been changed upon fermentation(?) of the juice which stood"three days in a warm place"?) No lactic acid found(p.323) but acetic(p.325).

The presence of malic acid is accounted for by the following test: Neutral acetate of lead produced a heavy flocculent white precipitate,which was partly soluble in acetic acid. The filtrate,after having been boiled with water, filtered while hot,and evaporated,deposited upon cooling,a small amount of a crystalline precipitate.

In 1872 McElhenie,acting upon the suggestion of Lancaster,re-examined the red tomato known in the market as the "Tilden." He purified the acids through the calcium salts from which they were regenerated by means of sulphuric acids. The "mass" thus obtained he examined according to "Will's tables" "and found present citric,malic and oxalic acids.." "Of citric acid he obtained as much as ten grains." Of malic acid he obtained an amount"larger than that of citric acid." Of oxalic acid "the yield was about equal to that of malic acid." None of these compounds were further identified by so much even as a melting point. Tartaric acid he failed to find. He infers "that the acids exist uncombined in the fruit."

"On following the schemes for the detection of organic acids as given in Fresenius' Qualitative Analysis, paragraph193,page 342,and Prescott's Organic Analysis, page 336,"Patterson in 1889 claimed to have found"the following acids.....in the concentrated juice of the tomato,viz.: malic,tartaric,benzoic,and formic. Malic acid predominated and the others appeared to be present in very small quantities."

In 1890 Briosi and Gigli made a rather detailed chemical study of the tomato. They claimed to have found citric acid,which was precipitated as lead salt and regenerated from the lead salt by means of hydrogen sulphide. The calcium salt precipitated from a hot solution, disappeared upon cooling and was readily soluble in acetic acid. These investigators,also Passerini(1890)determined by titration with alkali the amount of free acid computed as citric acid.

"A qualitative examination"made by Bowman in 1890, "showed the presence of citric,malic,tartaric,formic and succinic acids. Of these the citric acid was by far the most abundant,so that in the quantitative determinations the whole acid was calculated as citric acid."

In connection with his investigations with the sugar content of the tomato,Caldwell in 1892 also ascertained the "acidity"by means of a standard solution of potassium hydroxide,and calculated(it)as malic acid without,however, giving any reason for assuming the presence of this particular acid.

In a comparative study of the tomato, Bailey, in the same year, determined the percentage of acid but does not even state what acid was assumed in the computation of the percentages.

From the amount of CaO obtained from what the author calls "in Wasser loessl.oxals.Verbindungen," Abelee in 1892 states that the tomato contains 0.0099 g. of oxalic acid in 500 g. of fruit. Inasmuch as Abeles is one of the few who describe their methods, it should be quoted in detail:

"In order to effect a separation of the alkali oxalates from the lime, the material to be investigated was boiled with distilled water, the decoction filtered, the filtrate concentrated by evaporation and set aside for 24 hours that the calcium, which had not yet precipitated or which had passed through the filterate, might subside. The liquid was again filtered and treated essentially according to Neubauer. Calcium chloride was added, the solution heated, precipitation effected with ammonia and acetic acid added which causes a part of the precipitate formed to re-dissolve. The portion of the precipitate not soluble in acetic acid contains calcium oxalate, also calcium tartrate if the latter was present. (When only traces of these salts are present, it frequently occurs that no precipitate remains upon the addition of acetic acid. However, it is re-formed later when the solution is digested in a water bath for some time.) After 24 hours the mixture is filtered and the precipitate washed with water, to which a little acetic acid has been added, so long until the presence of calcium could no longer be demonstrated in the filtrate with ammonium oxalate. The acetic acid was then displaced by distilled water.

"In order to remove any calcium tartrate which might be present with the calcium oxalate on the filter, the precipitate was extracted with potassium hydroxide since, according to Barfoed, calcium tartrate is soluble in caustic alkalies whereas calcium oxalate is not. After the lye had been removed, the residual precipitate with the filter was boiled with hydrochloric acid, the solution filtered and the filtrate treated, as before, with ammonium and acetic acid and digested on the water bath. After 24 hours the precipitate was collected on a quantitative filter, washed, incinerated and heated on a platinum crucible over a blast. If the residue contained iron, its separation was effected according to Czapek, otherwise the brine was weighed and the oxalic acid computed."

In 1896, W.F.English published a rather remarkable article on a new disease which he calls Lycopersicum Cardiopathia or tomato heart which he attributes to the presence of acidum lycopersicum. The acid, like the peculiar disease, seems to have existed only in the imagination of this physician.

In an article on the composition and food value of the tomato, Harry Snyder, in 1899, computed the acid found as malic acid, 0.37, 0.41 and 0.47 p.c. being found in as many samples. The only argument, if it be such, recorded for assuming the presence of malic acid rather than any other acid is that a solution of levulose when evaporated with malic acid turns brown as do the tomato juice and pulp.

In 1906 Formenti and Scipiotti made a detailed study of Italian tomato products. The acid was titrated in the usual manner and computed as citric acid. These authors had previously observed the presence of what they regarded as salicylic acid, but never more than a few tenths of a milligram in the natural juice, and only up to one mg. in the concentrated juices. In order to identify this acid they proceeded according to the following method: "In a large porcelain evaporating dish 0.5 kg. or 1 kg. of tomato juice or sauce to which sulphuric acid had been added are treated several times in the well known manner with an ether mixture. The ether solution is transferred to a thin-walled glass flask of about 600 ccm. capacity, distilled from a water bath, the residue taken up with water. The same treatment is repeated 3-4 times for the sake of purification until a sharp reaction with ferric chloride is obtained. Finally the salicylic acid is determined colorimetically."

The amount found in 13 out of 19 samples varied from "traces" to 0.9 mg. in 1 kg. of tomato juice.

In 1906,Stuber examined tomatoes grown in northern Germany computing the total acid as citric acid.(0.41 and 0.48 p.c.) Concerning the character of the acids he makes the following statement:"Die Saere scheint in der Hauptsache als Citronen-saere vorzuliegen.In keinem Fall gelang es Weinsaere,Aepfelsaere oder Bernsteinsaere nachzuweisen," without however giving any experimental evidence for his assertion.

In "A complete analysis of the fruit of the tomato," Albahary in 1907 reports on the percentage of malic,citric, oxalic,tartaric and succinic acids,also gylcolic acid or its "analogue." The author distinguishes between the free and combined acids of the tomato. His methods are described in the first paper entitled "New method of separation and assay of organic acids in fruits and legumes." But in the paper referred to above he modifies the original methods in such a way that the mode of procedure is not quite clear. According to the general method,the free acids are extracted first by dry ether and then by "l'alcool a 90o" the residues are mixed and titrated. The combined acids (salts)are extraced with alcohol saturated with hydrogen chloride. "The residue from this solution is neutralized with ammonia and the entire amount precipitated with lead acetate,filtered and the precipitate while still moist heated to 70^{o} with dilute acetate acid for 1 hr. The lead malate alone dissolves. The mixture is filtered and 2 vol. of alcohol are added to the filtrate to precipitate completely the lead malate. This is removed by filtration, the malic acid is set free and determined quantitatively either as calcium salt or by titration.

"The original precipitate containing the salts of oxalic,succinic,tartaric and citric acids,is suspended in water,the lead removed by means of H_2S,the filtrate evaporated on a water bath to a small volume. A little acetic acid is added and then $CaCl_2$ and the mixture set aside for 24 hrs.,when the calcium oxalate will have precipitated. The mixture is filtered and the amount of oxalic acid determined.

"To the filtrate potassium acetate and 2 vol. of 95 p.c. alcohol are added and the mixture set aside for an hour when the acid potassium tartrate precipitated is filtered off, dried and weighed.

"The filtrate which contains nothing more than the citric and succinic acids is divided into two equal parts. From one the succinic acid is precipitated by means of gelatinous ferric hydroxide as basic ferric succinate $Fe(OH)\ C_6H_4O_4$,the citrate of iron remaining in solution. The other half of the filtrate is reduced on a water bath to a very small volume,3 vols. of alcohol are added and precipitation with barium acetate effected. Thus the succinate and citrate of barium are precipitated quantitatively. The mixture is filtered, the precipitate washed, dried and weighed. Hence one obtains on the one hand the combined weights of the salts of barium, and, on the other hand the weight if ferric succinate. Simple calculation will reveal the amounts of each of these acids."

In the report on the percentages of acids in the tomato, the author states that he modified the above process as follows"- "One precipitates first the tartaric acid, then the oxalic acid, and for the separation of the succinic acid, one uses "perchlorure de fer" ($FeCl_6$)?, which renders more easily the precipitation of this acid."

He then states that the free acids of the tomato are found in the following proportions:-

Malic	acid	0.48 p.c. of the fresh fruit.
Citric	"	0.09 " " " " " "
Oxalic	"	0.001" " " " " "
Tartaric	"	traces
Succinic	"	traces.

Nevertheless these acids do not constitute the total of the free acids, 42.9 ccm. of the 187.6 cc. normal NaOH solution required for the neutralization of the acids of the aqueous extract of the tomato not being accounted for. The other acid or acids thus indicated he regards as "probablement de l'acide glycolique ou analogues."

Of the acids combined with bases in the fruit, he finds:-

Malic acid	0.01 p.c.
Citric "	0.06 p.c.

Tartaric acid	infinitesinal amounts
Succinic "	" "
Oxalic "	" "

H.Pellet in 1907 discusses the occasional presence of salicylic acid in minute quantities,but does not record the methods by means of which this acid has been found or its amount ascertained.

In 1908 Albahary reports on a chemical study of the ripening of the tomato. Among numerous other data,he reports on the amount of non-volatile organic acids found in the green fruit before the seeds have been formed and in the ripe fruit,and finds it to increase from 0.116 to 0.58 to 0.42 p.c. He concludes hypothetically that the proteins first formed,at a certain stage in the development of the fruit are hydrolized yielding amido acids and that these are followed by the "acids". He also claims in support of his hypothesis that if the fruit be heated for some time to 110° the increase in acidity observed is accompanied by a loss of nitrogen.

In the same year Albahary published a general résumé of his work on the tomato in the Annales des Falsification which is of value because it contains a more concise statement of his method of isolating the several organic acids which he claims to have found.(p. 142)

In 1909 F.Peckolt published a brief résumé on the chemical work done on the tomato which includes three analyses,by himself ,of the Brazilian fruit. In two varieties of ripe fruit he found 1.003 and 0.564 of free acid recorded as citric acid.

In 1911 Bacon and Dunbar published a circular on the changes taking place during the spoilage of tomatoes. The acidity in sound tomatoes was found to be due to citric acid,negative tests being noted for malic,oxalic and tartaric acids. The citric acid,precipitated as the lead salt was identified by the barium content(determined as barium sulphate) of the barium salt.

Sound tomatoes were found to contain no volatile acids,but during the process of spoilage at ordinary temperatures the sugars were used up with the formation of acetic and lactic acids,and of butyric acid when decomposition took place at "rather high" temperature. Since sound tomatoes were found to contain considerable citric acid and no volatile acids and spoiled tomatoes to be rich in volatile acids and little or no citric acid,the authors propose these results as an index for detecting decomposition in tomatoes and tomato products.

In the same year Ricciardelli found citric acid to predominate,0.81 p.c.being present. Associated with the citric acid were traces of oxalic,malic and tartaric acids. (The original not being available,it is impossible to discuss the experimental evidence on which these conclusions are based.)

N.Monti in 1911 finds the acid to be glutaminic, 80 gm. of which were isolated from 60 Kg. of conserves. (In this instance also the original was not available, hence the experimental evidence upon which this statement is based is not known.)

In 1912 Albanarg in an analysis of the Italian tomato, is reported to have found that 187.6 cc.N Naoli solution were required to neutralize the acids in aqueous solution from 2584 gm. of tomatoes. The acids in the fresh fruit were found to be malic 0.48 p.c.,citric 0.09 p.c.,oxalic 0.001 p.c.,with traces of tartaric and succinic acids. The acids were present in the fruit combined with bases. (Compare bibliographic sheets 1907,Albahary,and 1912,Albanarg. The results being identical to the third decimal,it would appear that Albanarg of 1912 is identical with Albahary of 1907.)

		Malic Acid	"Peculiar" Acid	Citric Acid	Oxalic Acid	Tartaric Acid	Benzoic Acid	Formic Acid	Succinic Acid	Salicylic Acid	Glycolic Acid	Acetic Acid	Lactic Acid	Butyric Acid	Glutaminic Acid
J.F.John	1814	+	−	−	−										
Fodere-Hecht	1832	−	+	−	−										
Porcher	1849	−	+	−	−										
Plummer	1851	−	−	+	−										
Bertagnini	1855	−	−	+	−										
Lancaster	1859	−	−	+	−										
Enz	1862	+	−	−	−										
McElhenie	1872	+	−	+	+										
Patterson	1889	+	−	−	−	+	+	+							
Briosi-Gigli	1890	+	−	+	−	−	−	−	−	−	−				
Bowman	1890	+	−	+	−	+	−	+	+						
Caldwell	1892	+	−	−	−	−	−	−	−	−	−				
Bailey	1892														
Abeles	1892	−	−	−	+										
English	1896	−	+	−											
Snyder	1899	+	−	−											
Formenti-Scipiotti	1906	−	−	+	−	−	−	−	−	+					
Stuber	1908	−	−	+	−										
Albahary	1907	+	−	+	+	+	−								
Pellet	1907	−	−	−	−	−	−	−	+	−	+				
Peckolt	1909	−	−	+				−	−	−	−				
Bacon-Dunbar	1911	−	−	+	−	−	−	−	−	−	−	+	+	+	
Ricciardelli	1911	+	−	+	+	+	−	−	−	−	−	−	−	−	
Monti	1911	−	−	−	−	−	−	−	−	−	−	−	−	−	+

Bibliography.

John, J.F. 1814.

Lycopersicum Esculentum.

Chemische untersuchungen mineralischer, vegetabilischer und animalischer Substanzen. Fortsetzung des Chemischen Laboratoriums IV, p. (Rochelder Phytochemie, 1862, p. 146).

"The fruit contains volatile, disagreeable odorous substances, traces of red resinous material, extractive principles, gelatinous plant substances, a little albumen, potassium and calcium malate, potassium chloride, potassium phosphate, silicic acid and iron oxide."

Foderé, F.E. et Hecht, E. 1832.

Analyse des feuilles et des fruits de la pomme d'amour. (Solanum Lycopersicum).

Jour. de Pharm. et de Chem. 18, p. 105. (Ann. d. Chemie, 3, p. 130).

The authors give a partial analysis of the leaves and fruit of the tomato. They found the leaves to contain an "alkaline principle", calcium sulphate, "animal-like extract", coloring matter and a volatile oil. The fruit contains an acid, combined with a bitter principle probably analogous to solanine; also volatile oil, resin, an albuminous compound, a small quantity of "mucoso-sucre" (Schleim-zucker), potassium sulphate, potassium chloride, "potasse" pure" (in the ash) and probably an alkaloid. (?)

Poggio,- 1835.

Solanum Lycopersicum. (Liebesapfel).

Gazz. eclett., p. (Rep. fuer die Pharm.,2nd ser. 10,p. 218).

The author states that the coloring matter in the vines can be used as a dye for silk and wool.

Landerer,X. 1839.

Mittheilungen aus Griechenland: 2. Versuche mit Curcurbita Citrullus(Wasser-Melone),Solanum Melongena und Solanum Lycopersicum.

Rep. fuer die Pharm.,2nd ser.,17,p.104.

The author states that the green fruit of the tomato has a slightly astringent taste while the ripe fruit has a pleasant acid taste. In ripening the green pigment changes to a violet and red color which is soluble in hot alcohol.

Landerer,X. 1843.

Beitrage zur Kenntnis griechischer und tuerkischer Volksheilmittel.

Rep. fuer die Pharm.,2nd ser.,32,p.360.

Solanum Lycopersicum gegen Huehneraugen,p.366.

The author says that the people in Greece use the fruit of the tomato as a cataplasm for the cure of bunions.

Porcher,F.P. 1849.

Medicinal Plants of South Carolina, Indigenous and introduced.

Trans. Am. Med. Ass.,2,p.683.

Solanum Lycopersicum Tomato,p. 919.

" The fruit of this plant is well known as an article of food,it is slightly acid,and has a constipating effect,which renders it so appropriate as an article of food during the warm months of summer. The leaves are said to produce vomiting,from an alkaline principle which exists in them,they also contain calcareous sulphates,extractive,and a colouring matter,combined with a volatile oil. The alkaloid principle contained in the leaves is analogous to,if not identical with,solania. A peculiar oil,and an animalized extractive are also ascribed. The fruit contains a peculiar acid,and a brown,tarry,odorous resinous matter,with some indications of the presence of an alkaloid. It is said to act on the biliary functions".

Plummer,J.T. 1851.

Partial analysis of the tomato. Lycopersicum Esculentum.

Western. Lancet,Jan.1851. (Am. Jour. Phar.,23,p. 165).

The author concludes that potassium citrate with an excess of citric acid imparts to the yellow tomato its agreeable taste. He states his method for the detection of citric acid and for demonstrating the absence of other acids,such as tannic,gallic, acetic,benzoic,oxalic,malic, tartaric and paratararic acids.

Bertagnini, 1855.

Aepfelsaeure.

Il nuova Cimento,Compilato da Matteucci e Piria. PisaII, p.306. I.(Jahresbericht ueber die Fortsch der Chemie, 1855,p.478).

The author gives methods for the determination of malic acid in cerasus caproniana and apples. He states that there is no malic acid in unripe tomatoes but the acid found is citric acid.

Landerer, X. 1855.

Gebrauch der Fruechte von Solanum Lycopersicum.

Vierteljahresschr. fuer Prakt. Pharm., 4, p.508.

The author states that the tomato is used for both culinary and medical purposes. As a medicament he points out that it is used as a cataplasm, as cathartic, and as a remedy for gallstones.

Stieren, E. 1857.

Ueber Solanum Lycopersicum.

Vierteljahresschr. fuer Prakt. Pharm., 6, p.370.

The author states that the tomato is used for both culinary and medicinal purposes. As a medicament the pulp, with rhubarb and aloes, is a cathartic and sold as such under the name of Dr. Phelp's Compound Tomato Pills.

Lancaster, F.A. 1859.

Observations on the acids existing in the juices of rhubarb stacks, tomatoes and quinces.

Am. Journ. Pharm., 31, p.196.

The author concludes that malic acid identified by the ash content of the acid malate of calcium, and citric acid identified by the methods used by Plummer are to be found in the tomato "red variety", the citric predominating. He expresses the opinion that the citric acid exists as "citrate of potassa with an excess of citric acid," and that malic acid is present as "acid malate of lime".

Enz, J.B. 1862.

Ueber den Saft der Frucht des Solanum Lycopersicum.

Vierteljahresschr. fuer Prakt. Pharm., 11, p.321.
(Am. Jour. Pharm., 34, p.515.)

The author concludes that from his analyses of the tomato, the juice contains potassa, lime and some magnesia in combination with malic, tartaric, phosphoric, acetic and sulphuric acids, chlorine, also a gum resembling dextrine, albumen, starch, cellulose, fatty, and resinous substances, red coloring matter (cissotannic acid) but no solanin. He expresses the opinion that solanin exists in the seeds.

Mc Elhenie, T.D. 1872.

Lycopersicum Esculentum. Tomato.

Am. Jour. Pharm., 44, p. 197.

The author gives methods for determining the presence of citric, malic and oxalic acids in the tomato. He concludes that malic and oxalic occur in about the same proportion but in larger quantities than citric. Tartaric acid he fails to find. He infers that the acids exist uncombined in the fruit.

Kennedy, G.W. 1873.

Solania in Solanum Lycopersicum.

Am. Jour. Pharm., 45, p. 8.

The author gives a method for the isolation of the alkaloid solania from the vines of tomatoes. Besides the alkaloid he found some fixed oil, gum, chlorophyll, and inorganic salts.

Dahlen, H.W. 1875.

Beitrage zur Chemischen Kenntniss der Gemuesepflanzen.

Land wirtsch. Jahrbuecher, 1875, p.613.

Lycopersicum--Liebesapfel, p.631.

Lycopersicum esculentum vulgare. Eszbarer Liebesapfel, Paradies-apfel, Goldapfel, Tomato.

The author records an analysis of the fruit, the percentages of the constituents being calculated with reference both to the fresh fruit and the dry substance of the fruit.

Landerer, X. 1875.

Notes on some medicinal and dietetic articles.

Am. Journ., Pharm., 47, p.532.

Solanum Lycopersicum, p.535.

The author states that the pulp of the tomato is used medicinally for gravel and chronic rheumatism.

Glasspoole, H.G. 1876.

The history of cultivated vegetables. No. XVIII. The tomato or "love-apple" (Lycopersicum esculentum)

Science Gossip, 12, p.154.

The author gives a short history of the tomato.

Millardet, A. 1876.

Note sur une substance colorante nouvelle (solanorubine) découverte dans la tomate.

Nancy (Berger-Leorault) 1876, (21p.8). (Botanische Ztg., 34, p.734.)

"In the cells of the ripe tomatoes are found a great number of crystallized needles of coloring matter which the author calls solanorubine. The author describes the development of the solanorubine in the changing chlorophyll, its properties in its natural state, after extraction and recrystallization out of solutions. It is insoluble in water, soluble in alcohol at high temperature, easily soluble in carbon disulphide, chloroform and benzene. It becomes bleached in the light. It possesses no fluorescence, but does possess a very characteristic absorbent spectrum: two green bands following together at b and F., a band between F. and G. and a dark one at G.

"According to the author's view, the solanorubine is formed directly from the chlorophyll, hence the knowledge of the substance and especially of its constitution is of the greatest interest".

Mingiola, E. 1881.

Una cera ed una sostanza butirrosa del epicarpio della drupa del 'ulivo.

Gazz. Chim. Ital., 11, p.496. (Ab. Chem. Soc. Journ., 42, p.765.)

The author concludes that the wax and butterlike substances from the epicarp of the olive are identical with the pulverulent wax obtained by Prount (Compt. Rend., 16, p.863) and by Mulder (ibid., 30, p.53), from the epicarp of the plums, cherries and tomatoes.

Sturtevant, R.L. 1882.

Tomato.

Rep. N.Y. State Exp. Stat. 1, p.24.

A tabulated analysis of three samples of the early Achme tomato.

Cook, E.A. 1883.

On the production and excretion of uric acid.

Brit. Med. Jour., 1, p.246.

The author states that tomatoes contain malic and oxalic acids. He found that, due to their oxalic acid content, tomatoes have an influence on the secretion of urine and that they cause discomfort anf disorder in the urine patients troubled with gout.

C.F.W. 1885.

Tomatoes.

Science Gossip, 21, p.70.

"The fact that insects avoid ground where tomatoes are planted is well known. Indeed, our cucumber frames and narrow beds always have a row of tomatoes planted in them, to preserve the vegetable from insects."

A. Arnaud. 1886.

Récherches sur la composition de la carotine, sa fonction chémique et sa formule.

Compt. Rend., 102, p.1119.

the author concludes that carotin, the orange-red color of leaves is identical with the coloring matter in tomatoes. It has the composition $C_{26}H_{38}$ and crystalizes in rhombic plates with a metallic lustre. It combines readily with oxygen, chlorine, bromine, and iodine. With iodine it forms green crystalls. Carotin oxidizes in the air even at ordinary temperature, oxidation taking place very rapidly if the carotin is in solution or heated to 70°. The author concludes that it is an unsaturated hydrocarbon.

Reinitzer, F. 1886.

Ueber Hydrocarotin und Carotin.

Monatsch. fuer Chem., 7, p.597.

The author discusses the characterization of hydrocarotin and carotin, and by his investigation comes to the conclusion that carotin is identical with solanorubin, the coloring matter isolated from the fruit of the tomatoes be Millardet.

Briosi and Gigli. 1889.

Intorno alla stuttura anatomica e alla composizione chimica del frutto del pomodoro.

Rendiconti dell' Accademia della Scienze di Bologna,p.-

A preliminary study on the tomato published later in La Staz. Sper.1890.

1889.

Patterson,H.J.

Report of the Chemist.

II. The chemical composition of tomatoes. Report of the Board of Trustees,Maryland Exp.Stat.,1889,p.67.

The author gives a method of procedure for determining the chemical composition of tomatoes. He concludes that there are two classes of sugars present in the fruit,differing from each other in their behavior towards Fehling's solution. According to Fresenius' qualitative analysis,paragraph 193,p.342,and Prescott's Organic Analysis,p.336,the following acids were found present in the concentrated juice;viz. malic,tartaric, benzoic,and formic acids. As malic acid predominated the author calculates the whole of the acids as malic.

The following table gives the composition by varieties:

Variety	Water	Dry substance	Ash	Sugar	Malic	Solids sol. in water.
Achme	96.30	3.70	0.39	3.31:	1.18	4.06
Advance	96.38	3.62	0.41	2.94	0.92	3.83
Alpha,goods	96.01	3.96	0.45	3.09	1.20	3.84
Annie Dine	95.55	4.45	0.40	3.05	0.90	3.86
Atlantic Prize	96.40	3.60	0.36	2.74	1.04	3.92
Bay State	96.09	3.91	0.39	2.66	1.74	3.60
Beauty	96.31	3.69	0.32	2.64	0.84	3.40

Variety	Water	Dry substance	Ash	Sugar	Malic	Solids sol. in water.
Betle	96.41	3.59	0.35	2.86	1.37	4.02
Bermuda Ex.	96.39	3.61	0.40	2.63	1.14	3.88
Brandywine	96.04	3.96	0.33	3.33	1.20	4.35
Bronzed-leaved	96.04	3.96	0.39	2.99	0.90	3.90
Buists Beauty	95.48	4.52	0.44	3.38	0.97	4.10
Cardinal	96.18	3.82	0.36	2.97	0.92	4.40
Cincinnati Purple	95.66	4.34	0.49	2.50	1.44	4.00
Climax	95.92	4.08	0.37	3.52	0.94	4.10
Conqueror	96.00	4.00	0.49	2.61	0.92	3.43
Earliest of all	95.88	4.12	0.45	2.57	1.09	3.70
Early Gersey	95.86	4.14	0.42	3.22	0.80	4.10
Essex Hybrid	95.92	4.08	0.40	3.19	0.97	4.33
Ex.Eg.Advance	96.80	3.20	0.44	2.41	1.04	3.65
Faultless	96.52	3.48	0.43	2.76	1.09	3.85
Favorite	96.40	3.60	0.40	2.97	0.74	3.90
Gen.McClennan	96.81	3.19	0.38	2.54	0.50	3.60
Golden Trophy	95.38	4.62	0.45	3.52	0.90	4.20
Golden Queen	96.79	3.21	0.44	2.36	1.27	3.80
Hundred Day	96.16	3.84	0.40	2.75	1.05	4.02
Imp.Lge.Yellow	95.53	4.47	0.45	3.40	1.17	4.56
Ivory Ball	95.84	4.16	0.41	3.33	1.14	4.36
King Hubert	96.33	3.67	0.43	2.70	0.67	3.40
Large Yellow	95.53	4.47	0.45	2.79	0.83	3.96
Larillard	96.43	3.57	0.42	2.78	0.80	3.40
Matchless	96.24	3.76	0.43			
McCullonis Hybrid	96.07	3.93	0.62	2.94	1.27	4.30
Mikado	95.95	4.05	0.32	3.22	1.01	3.60
Mikado(different seed)	96.18	3.82	0.45	3.33	0.87	4.30
Morning Star	96.26	3.74	0.48	2.74	0.77	3.60
New Jersey	95.91	4.09	0.33	3.49	1.11	4.30
New Queen	95.81	4.19	0.44	3.14	0.88	4.33
New White Apple	96.40	3.60	0.43	1.79	1.44	3.40
Optimus	96.16	3.84	0.34	3.22	0.90	4.00
Paragon	95.78	4.22	0.37	3.38	1.40	4.30
Paragon(different seed)	96.06	3.94	0.42	3.45	0.97 "	3.84
Peach	96.44	3.56	0.40	2.93	1.18	3.78
Perfect Gem	96.06	3.94	0.39	3.09	1.54	4.50
Perfection	95.81	4.19	0.37	3.30	0.86	4.00
Potato Leaf	96.30	3.70	0.35	2.96	0.67	3.60
Prize Belle	95.98	4.02	0.32	3.22	1.11	4.20
Prize Belle(different seed)	96.49	3.51	0.46	2.33		3.74

Variety	Water	Dry substance	Ash	Sugar	Malic	Solids soluble in water
Puritan	96.32	3.68	0.34	3.16	0.94	4.00
Red Apple	96.30	3.70	0.47	1.76		3.02
Scoville's Hybrid	96.58	3.42	0.45	1.89	1.44	2.90
Station						
Sunrise Yellow	96.26	3.74	0.32	2.84	0.80	3.70
Shah	95.98	4.02	0.38	3.17	0.76	3.70
Tree (Dwarf champion.)	96.63	3.64	0.37	2.86	1.01	3.90
Tree						
Trophy	96.05	3.95	0.41	3.00	1.03	4.16
Turner Hybrid	96.30	3.70	0.44	2.38	1.54	3.60
Turner Hybrid	96.18	3.82	0.41		1.07	
Volunteer	96.86	3.14	0.35		1.54	
Haines(64)	96.16	3.84	0.40	7.75	1.05	3.51
Fire King	96.02	3.98	0.44		1.44	
Ignotum	96.89	3.11	0.44	2.42	1.14	3.40
Wonder of Italy	96.14	3.86	0.44	2.79	0.77	3.40
Early Puritan	96.30	3.10	0.38	3.09	1.07	3.86
Fulton Market	96.07	3.93	0.41	3.24	1.07	4.00

The food values of six samples expressed chemically are tabulated below. The author concludes that the red tomatoes are poorer in dry substance than the yellow varieties, but this dry substance is richer in the more valuable food constituents than in the case of the yellow. Nitrogen and albuminoid are found leas the yellow.

Water free su

Sample No.	H_2O	Dry substance	Ash	Fat	Crude Fiber	Protein	N.free Extract	Total N	Album. N.
806	96.31	3.69	8.07	11.09	16.85	19.65	44.34	3.13	2.47
826	96.16	3.84	8.10	11.65	16.50	22.66	44.34	3.13	2.47
830	95.53	4.47	7.24	9.45	14.79	20.18	41.09	3.23	2.50
838	95.81	4.19	8.26	10.37	14.54	21.43	45.40	3.43	2.40
854	95.98	4.02	8.92	9.29	14.38	19.02	48.39	3.40	1.80
857	96.05	4.03	11.32	7.75	15.34	19.19	46.40	3.07	2.43
Aver.	95.97	4.03	8.65	9.93	15.40	20.36	45.66	3.25	2.21

Nos. 830 and 854 were yellow tomatoes.

The author also states that there is no marked difference in the composition of tomatoes grown with different fertilizers. Potassium has the effect of producing a fruit with more dry substance and an increase in the acid content. The sweetest tomatoes are produced from plots with phosphoric acid. He records the variation of tomato decomposition relative to weather changes and gives methods for the determination of sugars and acids in fresh and air-dried substances of the tomato.

Alwood, W.B. and W. Bowman 1890.

A study of tomatoes. Chemical composition of tomatoes.

Rep. Virg. Ex. Stat. Series of 1889-90, Bull. No.4.

The authors give a method for the determination of water in tomatoes. From nine varieties the average water content was 93.63% water and 6.37% dry matter. They record proximate analysis of tomatoes, var. Trophies, vines and analyses made elsewhere.

	Calculated to Original samples.	Calculated to dry matter.
Water	93.343p.c.	5.07 p,c.
Crude Ash	.337 ""	7.05 " "
Ether Extract	.469 ""	15.68 " "
Crude Protein	1.044 ""	17.40 " "
Crude Fibre	1.158 ""	54.80 " "
Nitrogen-free extract	3.649 ""	

The following are the recorded analyses of tomatoes made elsewhere:-

	Calculated to orignal samples.						Calculated to dry matter.				
	Water	Fat	Fiber	Protein	Ash	Carbo-hydrate	Fat	Fibre	Protein	Ash	Carbohydrate
Dahlen	92.77	0.33	0.84	1.25	0.64	4.07	4.63	11.78	17.53	8.97	57.09
N.Y.Stat	91.26	0.47	0.70	1.00	0.73	5.84	5.38	8.01	11.44	8.35	66.82
N.J. "	94.00	0.41	0.54	.78	0.49	3.78	6.83	9.00	13.00	8.17	63.00

The following table shows the partial analyses of tomato vines.

	Original Sample.	Water free sample.
Water	87.8 p.c.	--------
Nitrogen	0.33 "	2.71 p.c.
Ash	2.28 "	18.68 "
Phosphoric Acid	0.088 "	0.72 "
Potash	0.61 "	5.05 "

Sturtevant, E.L. 1889.

The Tomato.

Report of the Board of Trustees Maryl. Exp. Sta., 1889, p.18.

The author has compiled an account of the early history of the tomato in America from the following papers and sources:-

(1) White Card. for the South p.312.
(2) Jefferson, Notes, Trenton, 1803, p.55.
(3) Felts' Annals of Salem, II., 631.
(4) Prairie Farmer, June 28, 1876.
(5) Am.Gard., May, 1835, 437.
(6) T.S.Gold, Sec'y Conn. Bd. of Agr., in private letter.
(5 1/2) Autobiog. of Thurlow Weed.
(7) Prairie Farmer, l.c.
(8) Hist. Mass. Hort. 8 vl., 269.
(9) Pat. of. Rept. 1854, 384.
(10) Matth. Comm. 1554, 479.
(11) Dodon. pempt. 1583, 455, fig. (12) Gerarde, Herbal. 1597, 275, fig.
(12) Gerarde, Herbal.
(13) Banhin, J., Hist., 1651, III, 620.
(14) Bryant, Fl. Diet, 1783, 212.
(15) Tournefort, Inst., 1700, 150.
(16) Pena and Lobel. Adv. 1570, 108; 1576, 108.
(17) Lytes' Dodoens, 1586, 508.
(18) Bauhin, Phytopin, 1596, 302.
(19) Tillius, Cat., 1723, 102.
(20) Wilkes, U.S. Exp. Exped. III., 3335.
(21) Brown, U.S. Pat. of Rept., 1854, 385(?)

(22)Dunal,Solan III.
(23)Sloane Cit. 1696,109.
(24)Descourt Pl.Ant.V,279.
(25)Gray,Syn.fl.II,226.
(26)Banhin prod.1620,90.
(27)Bryant fl.dict.,1783,212.
(28)Salisbury,Trans.N.Y.AG.Soc.,1848,371.

Voorhees,E.B. 1889.

Report of the Chemists.

Rep. N.J.Agric.Exp.Stat.10,p.23.

Experiments with Nitrate of Soda on Tomatoes.

II. Consideration of Chemical Composition.

The author gives a detailed analysis of the fruit of the tomato from plots differently fertilized with nitrate of soda.

Garrison,W.O. 1889.

Tomato Pomace Analysis.

Rep.N.J.Agric.Exp.Stat.,10.p.101.

An analysis of tomato pomace sent in by W.O.Garrison of Bridgeport,N.J.

Total nitrogen	0.42 p.c.
Total phosphoric acid	0.11 p.c.
Total potash	0.18 p.c.

Briosi,C.and T.Gigli 1890.

Su la composizione chimica e la struttura anatomica del del Frutto del Pomodoro.(Lycopersicum esculentum).

Le Staz. Sper. Agrar. Ital.,18,p.5. (Ab. Chem.Soc., Jour.60,p.955.)

The ripe fruit of tomatoes was separated into undried skins(3.7p.c.),undried seeds(10.9 p.c.),and pulp(85.4 p.c.). The pulp was further separated by filtration into a red,insoluble substance and a yellow liquid. The various constituents of the tomato were determined qualitatively and then quantitatively with reference to the yellow juice,dried matter of juice, dried red insoluble substance,dry pulp,and then finally computed with reference to the tomato proper.

Palmeri,P.

Sui Pomodoro.

Annuario della R.Scuola Superiore d'Agricoltura in Portici,5,Fasc.1. (Le Staz. Sper. Agrar. Ital.,18, p.28.)

The author gives an analysis of the tomato and records his analysis to the fresh fruit and the dry matter of the fruit. He also records a quantitative determination of the constituents of the ash.

Passerini,N. 1890.

Sulla composizione chimica del frutto del Pomodoro.

(Solanum Lycopersicum L.) Staz. Sper. Agrar. Ital.18, p.545. (Ab.Chem.Soc.Jour.,60,p.956.)

The fresh fruit of tomatoes consists of skin(1.3), pulp and juice(96.2),and seeds(2.5per cent). The pulp contains two colouring matters,a yellow,amorphous substance and a red,crystalline substance. They are both insoluble in water,soluble in amyl alcohol,and very soluble in ether,and both are decolorised by chlorine-and bromine-water. The red crystals are almost soluble in cold alcohol,whilst the yellow compound is very soluble. Hydrochloric acid has no action on either compound.

The juice of the fruit has a sp. gr. of 0.01834 at 15° and is laevorotatory. It contains a yellow coloring matter which differs from that of the pulp in being soluble in water,insoluble in alcohol,ether,chloroform,and light petroleum,and is not decolorised by chlorine-water or bromine water. The acidity of the sap is due chiefly to citric acid;it contains also a small amount of an alkaloid,which,like the acid decreases as the fruit ripens.

The author records tables giving the compositios of skins,pulp,sap,seeds,ripe and unripe fruit and the ash of the fruit.

Patterson,H.J. 1890.

Chemical portion of the Tomato work.

Bull. No.11,Maryland Agric. Ex. Stat.,p.61.

The author records the average composition of tomatoes from plots differently manured. He concludes that potassium has a tendency to produce a fruit with slightly less sugar and more acid,and that phosphoric acid produced sweet tomatoes.The vines and roots are particularly rich in potassium and add to the fertility of the soil when returned thereto. The tomato is not an exhausting crop when compared with others. The roots and vines contain more fertilizing material than similar remains of other crops.The following table gives a partial average,analysis of 24 samples of the fruit,vine and root of the tomato.

	Fruit	Vine	Root
Water	95.45 p.c.	79.11p.c.	73.31 p.c.
Total dry matter	4.55 "	20.59 "	26.69 "
Organic matter	4.132 "	16.87 "	14.97 "
Pure ash	0.148 "	3.72 "	11.72 "
Phosphoric acid		1.70 "	1.45 "
Potash	0.045 "	0.044"	0.059 "
Lime Ca_o	0.269 "	0.389"	0.292 "
Nitrogen		0.546"	0.303 "
	0.155 "	0.313"	0.236 "

Bowman,W. 1891.

Chemical Examination of Fruits.

Rep. Virg. Ex. Stat.,Bull.No.9,p.16.

The author concludes that malic,citric,tartaric, formic and succinic acids were detected but that citric was more abundant. He also concludes that the sugars in tomatoes are of the glucose kind. From eleven varieties the following average data were ascertained.

Quantities of $\frac{N}{10}$ NaOH to neutralize 1 gm. of Tomatoes.	Percent of free acids calculated as citric.	Percent of Glucose.	Percent total solids.
Mean 1.06cc.	Mean 0.71	Mean 2.09	Mean 3.88

Janssen, A. 1891.

Conserva di Pomodora.

Pharm. Zitg., 36, p. 559.

The author gives the synonomy of the tomato and discusses its culinary uses. Of the conserves he distinguishes those made by fermentation and those made by boiling.

Abelee, M. 1892.

Ueber Alimentaere Oxalurie.

Wiener kl. Wochensch., 5, pp. 276 and 296.

The author reviews the history of the occurrence of oxalic acid in tomatoes, tea, carrot, rumex and spinach. From his own experiments he finds .0099 gms. of oxalic acid in 500 gms. of tomato fruit. He states that the acid is not injurious to the human system.

Bailey, L. H. 1892.

Do fertilizers affect the quality of tomatoes?

Rep. Agric. Exp. Stat. Ithaca N.Y. 1892, p. 456.

The author gives an analysis of the solids, sugar and acid content of tomatoes grown from differently fertilized plots.

Caldwell, G.C. 1892.

The determination of sugar in the tomato.

Rep. Agric. Exp. Stat. Ithaca, N.Y., 1892, p.399.

The author gives volumetric and gravimetric methods for the determination of sugar in tomatoes. He records the analyses of dry substances, sugar and acid content of thirteen samples. The acid was calculated as malic acid.

Waage, T. 1892.

Ueber das Vorkommen saponinartiger Stoffe im Pflanzenreiche.

Pharm. Centralhalle, 33, p.712.

The author discusses the occurrence of saponin in the plant kingdom. Among the plants of the solanaceae family the tomato was found to contain the glucoside saponin.

Bernegau, L. 1894.

Die Tomatenzucht im Garten der Landapotheke.

Apoth. Zeit., 9, p.797.

The author gives a brief account of the history, chemical composition, cultivation and uses of the tomato.

Passerini, N. 1893.

Composition of the Stems and Leaves of the Tomato. Presence of Boron, Lithium and Copper in the plants.

Staz. Sper. Agrar., 20, p.471-(Ab. Chem. Soc., Jour.64, p.225.

"The author has already investigated the composition of the fruit of tomatoes(Abstr., 1891, p.956). As regards the stems and leaves, the fresh stems contained 8.84-9.92 per cent of dry matter and 1.57-1.96 per cent of crude ash; the fresh leaves contained 11.62-14.62 per cent of dry matter, and 1.60per cent of crude ash. The dried stems and leaves contained respectively 1.8995 and 1.4374 per cent of nitrogen. The percentage composition of the pure ash of (I) the stems and (II) the leaves was found to be as follows:

	K_2O	Na_2O	CaO	MgO	Fe_2O_3	Mn_3O_4	P_2O_5	SO_3	SiO	Cl
I.	24.95	11.08	32.80	7.87	0.84		2.29	4.69	6.05	14.5
II.	1.95	1.37	38.14	9.00	0.14	0.05	1.36	12.79	33.84	1.18

A good crop(50,000 kilos of fresh fruit per hectare), excluding the leaves, which are usually returned to the soil, would take from the soil, nitrogen, 113.7 kilos; phosphoric anhydride, 50.7 kilos; potash, 256.6 kilos; lime, 58.4 kilos and magnesia 23.8 kilos.

An aqueous extract of the ash of the stems, from which sodium and potassium had been separated, was examined spectroscopically when the lithiun line was distinctly seen. Another portion of the extract was found to contain boron(Rose's method). The insoluble portion of the ash contained copper in quantity sufficient to be detected by means of ordinary reagents. In connection with this, it is mentioned that the plants analysed were grown in the open country, and that no copper preparations had been used for destroying injurious insects; in the analytical processes, the use of copper vessels was avoided. Barium and strontium could not be detected". N.H.M.

1896.

Ehring, C.

Ueber den Farbstoff der Tomato, ein Beitrag fur Kenntniss des Carotins. (Inaugural-Dissertation Muenchen.)

Ehring found that the color of tomato had a different absorbtion spectrum from that of carotine. (Quoted by Kohl. q.v.)

1896.

English, W.F.

Lycopersicum Cardiopathia.

Journ.Am.Med.Ass., 26, p.1255.

The author claims that a "tomato heart" is the result of tomato poisoning due to the "acidum lycopersicum" which this fruit is supposed to contain.

Owing to the peculiarity of the claims the following extracts may best serve to illustrate the author's position.

"Observations have been conducted over fifteen years and experience assures one that one-half of those who use them suffer more or less,while one-fourth are obviously injured. A small percentage exhibits all the evidences of acute poisoning."

The symtoms first noted are those of immediate effects of acidum lycopersicum upon the stomach and prima via."

There is a peculiar virulence to acidum lycopersicum that cannot be easity overpowered and its effects remain apparent in the stomach and intestines for some days,despite the use of alkaline purges and occasional draughts of lime or potash water".

Snyder,Harry. 1899.

Tomatoes. Composition and food value.

Minn.Agr.Expt.St.Report.,1899,p.513.

In view of the fact that a lack of uniformity of results on the composition of tomatoes occurs,a chemical examination was made of three typical varieties,viz., "Acme","Livingston",and "Dwarf aristocrat."The amounts of sucrose,dextrose,levulose,protein,amides,fat,malic acid (calculated as such),ash,water,and total solids are tabulated.The author also found that the same results could not be obtained when fresh or dry substances were used for analysis.This fact was especially true in the case of sugars.

Inasmuch as the juice contains much of the nutrients of the tomato,the loss of nutrients in canning tomatoes was determined by canning some samples without juice and others with the juice.

Battaglia,L. 1901.

Ricerche sull' Olio dei semi di pomodoro.

Ann.della Soc.Chem.di Milano,1901,p.127.

The author obtained from the seeds of tomatoes by means of a pressure of 500atm.a dense yellowish-brown oil of a characteristic odor. By analysis he determined the following constituents of the oil.

Moisture	36 p.c.
Acids of insoluble fats	95.10 p.c.
Volatile fatty acids(100gm.oil	18.9 cc.of $\frac{H}{10}$ alkali)
Acidity of the oil(1gm.oil	4.7cc.$\frac{H}{10}$ alkali)
Iodine value of the oil	106.10
Iodine value of the fatty acids	112.
Saponification value	190.4
Index of refraction	71.5
Specific gravity	15°C 0.922.
Lecithin	gr.2.303 p.c.

From the sodium soap of the oil the author isolated lecithin and cholesterin. The lead soap showed the presence of oleic,linolic,myristic and stearic acids.

Kohl,E.G. 1902.

Untersuchungen ueber das Carotin und seine physiologische Bedeutung in der Pflanze. (Leipzig, Gebrueder Bornotraeger. One vol.,p.206.)

The author states that the coloring matter of tomato is identical with that of carotin. He also criticises C.Ehring's results in that the absorbtion spectrum of the tomato color is different from carotin. pp.40-42.

Schunck, C.A. 1903.

The xanthophyll group of yellow coloring matters.

Proc. of the Roy.Soc., 72, p.165.

The author regards the "pigment of tomato" as one of the xanthophylls which occur in flowers, fruits and leaves. He gives a method of extraction and obtains deep red crystalline needles from ether. He gives the reactions with different reagents and believes that it belongs to the characteristic group of xanthophylls. From the absopbtion spectra and reactions he concludes that the color has been mistaken for carotine and gives it the name lycopin.

Montanari, C. 1905.

Red Coloring Matter of Tomatoes.

Staz.Sper.Agrar.Ital., 37, p.909. (Chem.Soc.Jour., 88(I) Abstr.p.293) (Chem.Centbl., 1905(I), p.544.)

The author concludes that the coloring matter from tomatoes is not carotin. It melts at 170°, has the formula $C_{52}H_{74}$, molecular weight of 635-650. With iodine it forms a green precipitate which when analyzed proved to be a condensation product of two molecules of carotin and two atoms of iodine and therefore could be regarded as a dicarotin.

Paradis, 1905.

Empoisonnement par des tomates de maturité insuffisante.

Les Nouv. Rémedes 21, p.115. (Proc.Am.Phar.Ass.53, p.63).

Paradis reports two separate cases of poisoning from eating unripe tomatoes. The symtoms were colic and violent diarrhoea, with dilation of the pupils; the treatment which was rapidly successful in removing the worst symtoms, consisted in the administration of ipecac and hot alcoholic stimulants.

Formenti, C. and A. Scipiotti. 1906.

Zusammensetzung Italienischer Tomatensafte.

Zeitschr. f. untersuchung d. nahr. u. Genussmittel, 12p. 283.

The authors give a detailed analysis of tomato juices, concentrated tomato extract and tomato fruits for water, ash, nitrogenous substances, sodium chloride, carbohydrates, crude fiber, acids, foreign coloring matter, salicylic acid, benzoic acid and tin. In the investigation of the tomato fruit the coloring matter is discussed. It was also found that salicylic acid occurs naturally to the extent of 25mg. per liter in the tomato.

Stuber, W. 1906.

Ueber die Zusammensetzung der Tomate und der Tomatensaftes.

Zeitsch. f. Untersuchung d. Nahr. u. Genussmittel, 11, p. 578.

The author gives the following percentage results obtained on the analysis of tomatoes and of the juice.

I. Whole fruit Oct. 1905.

Constituents in 100 gm. of the substance.	I.	II
Water	95.52	5.13
Dry substance	5.48	4.87
Nitrogen	0.116	0.159
Nitrogenous substances	0.725	0.994
Mineral substances	0.50	0.63
Alk. of ash(cc.n.acid)	4.62	5.50
Alkali number	9.24	8.73
Extract insoluble in water	2.17	1.49
Petroleum ether extract	0.06	0.07
Sugar(before inversion)	2.53	3.21
As Invert(after inversion)	2.51	3.19
Not sugar(dry substances abstracts from sugar)	3.00	1.66
Free acid as citric	0.41	0.48
Phosphoric acid	0.044	0.059

The mineral constituents II, in 100gm. of fruit are as follows expressed in grams.

K_2O	Na_2O	CaO	MgO	Fe_2O_3	SiO_2	P_2O_5	SO_3	Cl	CO_2
0.346	0.013	0.013	0.021	0.004	0.005	0.654	0.032	0.034	0.121

Tomato Juice.

Constituents in 100ccm. juice				
Sp, gravity 15°	1.0190	1.0185	1.0203	1.0160
Sp.gr. of fermented juice	1.0188	1.0183	1.0183	1.0160
Extr. (grav. 21/2 hrs.				
(in steam oven.	4.	3.81	4.52	3.84
(indirect, after addition process	4.22	3.94	4.77	4.01
(indirect, after sugar tabulation	4.86	4.73	5.56	4.81
Total acidity as citric	0.60	0.69	0.46	0.48
Total sugar				
(before inversion	2.34	1.98	2.50	1.74
after "	2.34	1.96	2.53	
As invert (discolored juice	2.36	1.96	2.49	1.66
Glucose	0.83	0.57	0.93	0.62
Fructose	1.53	1.39	1.56	1.04
Mineral sub. (ash)	0.50	0.63	0.65	0.66
Mineral sub. united with citric acid.	0.67	0.83	0.86	0.87
Alkalinity of ash (ccm.N.acid)	5.2	6.00	6.4	6.4
Alkali number	10.40	9.52	9.85	9.70
Nitrogen	0.098	0.088	0.128	0.127
Phosphoric acid	0.031	0.039	0.025	0.027
Sub. pressed out in sugar but abstracting from it				
a. citric acid and sugar	1.28	1.29	1.78	1.79
b. cit. acid, sugar, mineral sub. united with citric acid	0.61	0.46	0.92	0.92
Polorization in 220mm. tube	-1.96°	-2.0°	-2.0°	-1.34°
	20°C	20°C	15°C	15°C.

Constituents of the ash of the juice expressed in gms. per 100cm.

	Total ash	K_2O	Na_2O	CaO	MgO	Fe_2O_3	SiO_2	P_2O_3
II.	0.629g.	0.361	0.021	0.008	0.017	0.004	0.039	0.015
III.	0.666g.	0.384	0.019	0.008	0.017	0.002	0.028	0.007

	Cl	Co_2
II	0.038	0.132
III	0.072	0.141

The acid consists principally of citric,tartaric and malic. Succinic could not be detected.

Albahary,J.M. 1907.

Analyses complete du fruit du Lycopersicum esculentum on Tomate.

Compt.Rend.,145,p.131. (Chem.Soc.Jour.,92,Abstracts(2) p.715).

"The fresh fruit contains water 93.5 p.c."

"Nitrogenous substances" 0.95 p.c.(of which 0.028 p.c. are organic sulphur compounds.)

"Substances free from N." 0.50 p.c.

Fat 0.2 p.c.

Carbohydrates 3.6 p.c.(glucose,fructose and saccharose)

"Insoluble substances" 1.80 p.c.(1.69 p.c. organic
(0.11 p.c. inorganic

Ash,total 0.74 p.c. of which 0.12 is phosphate of lime.

Malic acid 0.48	Tartaric acid traces
Citric acid 0.09	Succinic acid traces
Oxalic acid 0.001	Glycolic acid

Most of the acids occur in the free state.

Duerkop, W. 1907.

Ein Beitrag zur Geschichte der Tomato.

Naturwissensch. Wochensch., 22, p. 545.

A critical historical account based on original documents.

Pellet, H. 1907.

Sur la présence de l'acide salicylique dans les tomates; la question des expertises.

Ann. Chim. Anal., 12, p10. (Chem. Soc. Jour. 92 II, p. 139)

"The author agrees with Ferreira da Sila that the presence of 10Mg. of salicylic acid in 1 kilo of tomatoes should not be regarded as indicating adulteration as it occurs naturally, although only in traces." L. de K.

Willstaetter und Mieg, W. 1907.

Ueber die gelben Begleiter des Chlorophylls.

Ann. der Chem., 355, p. 1. (Chem. Soc. Jour., 92, p. 865.

The authors record the results of their investigations of two yellow pigments, carotin and xanthophyll which occur with chlorophyll in green leaves.

"Carotin, obtained by extracting stinging-nettle leaves with light petroleum, crystallises in copper-colored leaflets which appear red by transmitted light, and is undoubtedly identical with the carotin obtained from carrots. The results of analysis and molecular weight determinations show that it has the formula $C_{40}H_{56}$, and not $C_{26}H_{38}$, as assigned to it by Arnaud (Abstr., 1885, 670; 1886, 711; 1887. 859). It is probable that erythrophyll (Bongarel, this Journ., 1877, ii, 790) and chrysophyll (Schunck, Abstr., 1889, 279) are identical with carotin, and that Husemann's carotin (Annalen, 1861, 117, 200) is a definite oxidation product of carotin, $C_{40}H_{56}O_2$, isometric with xanthophyll.

Carotin absorbs oxygen to the extent of 34.3 p.c. of its weight,being converted into a colorless substance(compare Arnaud,Abstr.,1890,285). It likewise combines with iodine,forming carotine,iodide,$C_{40}H_{56}I_2$, which crystallises in rosettes of dark violet prisms and sinters and decomposes at 140-170°.

Xanthophyll,which accompanies chlorophyll in the alcoholic extract of leaves,is similar to carotin in appearance,but differs from it in that the crystals appear yellow in transmitted light. Molecular weight determinations and analysis show that it has the formula $C_{40}H_{56}O_2$. It combines with methyl and ethyl alcohols forming the substances $C_{40}H_{56}O_2CH_4O$ and $C_{40}H_{56}O_2C_2H_5O$; the alcohol is slowly given off in a vacuum.

Xanthophyll is an indifferent substance,and reacts neither as an alcohol,acid,nor ketone. Like carotin it readily absorbs oxygen to the extent of 36.55 per cent of its weight. From the oxidised material, the compound,$C_{40}H_{56}O_{18}$,was isolated in the form of a white,crystalline powder,which swells up at 100° and melts slowly at 140°.

Xanthophyll readily unites with iodine,forming xanthophyll iodide,$C_{40}H_{56}O_2I_2$,which crystallises in tufts of thin,dark violet prisms with a mettalic lustre.

The authors maintain that it is impossible by the methods of Kraus,Sorby(Proc.Roy.Soc.,1873,21. 442),and Marchlewski and Schunck(Trans.,1900,77,1080) to obtain chlorophyll free from carotin,and they show further,that Kraus's method is superior to that of Sorby for the separation of xanthophyll from chlorophyll." W.H.G.

\- 1907.

Tomatenblaetterextrakt gegen Insekten.

Kons.Ztg.,1907,p.301.(Pharm.Centrh.48,p.460.)

The author states that the solanine content of tomato leaves makes an excellent remedy against insects,especially the insects found on the tobacco. After the harvest the leaves are dried,extracted with water and the aqueous solution evaporated to a syrupy consistency. This solution diluted twenty times,is used as a wash or spray for insects.

Albahary, F.M. 1908.

Etude chimique de la maturation du Lycopersicum esculentum(Tomate).

Comp.Rend.147,p.146. (Ab. Chem. Soc. Jour.94,II,p.774).

"During ripening a considerable increase in the amount of organic acids,sugars,starch,and non-protein nitrogenous substances take place whilst proteins and cellulose diminish."

A detailed statement of the analytical data will be found in the following table.

Constituents.	Green fruit I	Green fruit II	Ripe fruit. III
Water	93.63 p.c.	94.27 p.c.	94.39 p.c.
Volatile substances	0.03 " "	0.12 " "	0.08 " "
Alcoholic ext.	1.42 " "	3.76 " "	4.48 " "
Fat	0.046" "	0.08 " "	0.01 " "
Organic acids "fixed"	0.116" "	0.58 " "	0.42 " "
Sugars	0.65 " "	2.07 " "	2.12 " "
Sugars after hydrolysis	0.29 " "	1.14 " "	1.60 " "
Nit.non-protein sub.	0.02 " "	0.09 " "	0.09 " "
Ash,sol.	0.15 " "	0.45 " "	0.38 " "
Residue,dry "extract"	4.90 " "	1.81 " "	1.08 " "
Acid	2.08 " "	0.76 " "	0.80 " "
Protein nit.	0.29 " "	0.097" "	0.06 " "
Albumen	0.18 " "	0.04 " "	0.038" "
Nucleine	0.12 " "	0.06 " "	0.024" "
Sugar,Glucose	0.05 " "	0.09 " "	0.07 " "
Starch	0.07 " "	0.41 " "	0.036" "
Cellulose	0.755" "	0.32 " "	0.27 " "
Ash, insoluble	0.14 " "	0.14 " "	0.10 " "

I.Before seeds had formed.
II.After seeds had formed.

Kochs, J. 1908.

Characteristics of oils from certain expressed seeds.

Mitt.der Kgl.Gartner Lehranstalt zu Dahlem. Chem.Rev. Fett.u.Harz-Ind., 1908, 15, pp.256-257; Jour.of the Soc. of Chem.Ind.27, p.1072.

The author gives the characteristics of oils from expressed seeds among which is the tomato seed oil. He gives the yield as 17.37% from the seeds. Characterizes it as a reddish brown and semi-drying oil and could probably be used as an edible oil.

He gives the following data of the oil:

"Sp.gr. at 15°C	0.9200
Saponification number	183.6
Iodine number	117.8
Reichert-Meissl value	0.22
Butyro refractometer, degrees at 40°C	.63°
Solidification point (viscous at -9°C	
(Semi-solid at -12°C	
Fatty acids	
Melting point	26°-29°C
Iodine value	129.6
Mean molecular weight	281.5
Unsaponifiable matter per cent	1.86%

Albahary, J.M. 1909.

La Tomate.

Ann.des Falsifications, 2, p.140.

The author claims that physicians who condemn tomatoes for their oxalic acid content are wrong, for the slight amount of acid present is incapable of causing the least disturbances in the system. The author records an analysis of both ripe and unripe tomatoes. He finds nothing injurious present, but comes to the conclusion that thr ripe fruit is very nutritious. The green fruit contains more protein and acids but less sugar than the ripe fruit, but the protein is undigestible.

Peckolt,Th. 1909.

Heil und Nutzpflanzen Brasiliens'. Solanum Lycopersicum. L.(p.195.)

Ber.der Phar.Gesellschaft,19,p.180.

The author discussed the therapeutic value of the fruit,gives a short history of its chemistry,of its analysis and compares his analysis of both green and ripe tomatoes with the results of former investigators. An analysis of the fresh leaves showed the presence of 0.0438 p.c.solanin.

Accomazzo,P. 1910.

Utilizzazione dei cascami della lavorazione del pomodoro.

Rivista di Agric.16,Parma pp.371,387,401,417,433,450, 465,481,497,531,545,561,578,611,625,658,673,689,706. (U.S. Agr.Ex.Stat.Rec.24,p.311..

In a series of articles the author discusses the utilization of the tomato waste products,viz. seeds and skins.

I. The Importance of the Agricultural and Industrial Problem.

The La Societa Parmense began in 1910 to utilize the residues of tomatoes to make them an object of commerce. Accomazzo states that in the province of Parme,Italy,from 850,000 cwt.of fruit produced 42,000 cwt. of seeds and skins of which 30,000 cwt.were seeds alone. Since the seeds yield 18 p.c.of oil by expression or 20 p.c.by solvent, there would result 6,000 cwt. of oil representing 300,000 livres($60,000) at the lowest estimate.The waste after the extraction of the oil when sold as fodder would represent a value of 240,000 livres. ($48,000).

II. The Oil of the Seeds.

The oil from the waste seeds is the most important by-product. The seeds and skins are dried naturally or artificially. The latter method has as yet not proved satisfactory. The apparatus used consists of a large revolving cylinder of canvas with a ventilator sending a blast of hot air through it. The seeds are separated from the skins by means of sieves or blowers. The latter method does not affect a complete separation since many seeds on account of their lightness, are hurled through the sieves with the skins. The following results were obtained with the method:

Pure seeds	65 p.c.
Skins.	25 " "
Skins, impurities, broken seeds	10 " "

The seeds were reduced to a fine powder with the cylindrical crushers of the "Bamford Mills" and by the use of mill-stones.

Extraction of the oil.

The oil was extracted from the seeds in two ways,
(1) By means of pressure.
(2) By means of a solvent.

Pressure. By this method the seeds were soaked in water with the aid of heat until they could be made into little balls. They are then squeezed through cheese cloth, transferred to a powerful wine-press, with the aid of which a dense reddish oil was obtained. The expression was tried upon three different products of varying degrees of fineness, and the results are tabulated below.

Quality of material.	Quantity of material.	Oil obtained.	Percent of oil.
Seeds and skins not communited	50 Kg.	5 Kg.	10 p.c.
Seeds slightly powdered with a Bamford mill	80Kg.	10.5 Kg.	13 p.c.
Pure seeds powdered with mill-stone	50 Kg.	10.8 Kg.	18 p.c.

By means of a solvent.

The fine powder of the seeds, when extracted with a solvent such as carbon bisulphide, benzin, petroleum ether or tetrachloride gave a yield of 20 p.c. The solvent selected should be such as not to lower the value of the meal.

The following physical and chemical properties of the oil are recorded:-

Sp. gravity @ 13°	0.920
Index of refraction (But.Ref.)	63°
Saponification number	183.6
Ester number	174.6
Reichert-Meis-Wolney number	0.22
Iodine number	117.
Iodine number of the fatty acids	129.4
Saponification number of fatty acids	198.2

III. The Utilization of the seeds and skins.

The Utilization of the oil of the seeds.

The oil of the tomato seed possesses burning qualities approaching those of olive oil. Its flame is clear and full of light but a soot is formed due to impurities.

The oil can be classed among the semi-drying oils and should be of special interest to the industry of fatty varnishes and oil paints. When subjected to heat the oil dries in four or five days. The oil was also heated for four or five hours at a moderate heat with a bag of litharge suspended in it. The oil then dried in 3 or 4 days. By means of heating and applying oxidizing substances one can greatly increase the drying power of the oil so that it can be used in the preparation of paints and fatty varnishes.

As a source for soap stock the oil is not well adapted since upon treatment with soda it yields soft products, hence it cannot be used for the manufacturing of hard soaps but might be used for the production of soft soap.

B. Utilization of the skins.

The skins obtained in the province of Parme represent 10,000 cwt. of the tomato industry. The skins are rich in cellulose and experiments have been carried out in Parme which indicate that they may be regarded as prime material for paper. They yield 25% of raw fibre.

IV. Chemical Physiological Composition.

The analysis of tomato waste includes the determinations of water, ash and organic substances. In the organic group the proteid, fat and non-nitrogeneous substances were determined to show that the residues have a decided nutritive value. The following table gives the percentage of the raw elements, the coefficient of digestion and the percentage of digestible substances in the seeds:-

	Percentage	Coefficient of digestibility	Percent of digestible substances.
Water	6.80 p.c.		
Ash	6.20 p.c.		
Proteids	23.10 " "	77.83	17.98p.c.
Fat	20.50 " "	98.47	20.18" "
Cellulose	25.56 " "		
Non-nitrogeneous substances	17.84 " "		17.84" "

The nutritive value of the marc of the seeds when compared with that of the marc of other seeds shows up well. The presence of skins decreases the nutritive value. After the oil of the seeds has been extracted by pressure, small cakes of marc result in which all but 21 to 23% is digestible. The percentage composition of the seeds after the extraction of the oil shows that it has great nutritive value in proportion to the cost. The following table gives the physiological chemical determination of the residues.

Raw Substances.

Water	Dry substances.	Ash	Protein	Fat	Extracted non-nit. matter.	Cellulose
6.80p.c.	93.8p.c.	6.20p.c.	23.10	20.5	17.84p.c.	25.56

Digestible Substance.

Fat	Total non-nitrogenous matter	Nutritive Report	Commercial unit.
20.18p.c.	17.84 p.c.	3.73 p.c.	112

The residual cake of seeds after the extraction of the oil when mixed with 45% of molasses produces a fodder of high nutritive value for various animals. The cakes without the molasses are so nutritive that they can be used to feed cows. The cows easily grow used to the new food and do not feel any physiological disturbance of any kind. It increases the flow of milk which shows no change in its physical or chemical composition. The rations modified with tomato meal mean economy as to other food rations. The author concludes that the use of tomato residues as fertilizing material or as fuel is very poor.

Groth, B.H.A. 1910.

Structure of tomato skins.

New Jersey Agric. Exp. Stat. Bull. No. 228, p. 1.

The author gives an account of the histology of the tomato skins. He discusses from the microscopical point of view, the coloring matter, mucillage, and oil occurring in the skins of nine different varieties.

Mack, F. 1910.

Feeding Stuffs.

Ber. Grossh. Bad. Landw. Vers. Anst. Augustenb., 1910, p. 17.

U.S. Dept. Agric. Exp. Sta. Rec., 26, p. 266.

The author records analyses of various meals among which is a sample of tomato meal. Tomato meal consists mainly of the seeds and skins. The following composition is given:-

Water	9.5 p.c.	Nitrogen free extr.	p.c.	17.44
Protein	21.44" "	Fibre	"	25.7
Fat	19.0 " "	Ash	"	6.92

Perciabasco, F. Semeraro 1910.

Utilizzizione dei residui della lavorazoine del pomodoro.

Staz. Sper. Agrar. Ital. 43, p. 260. (Ab. Chem. Soc. Journ. 94(2) p. 310.

The authors state that tomato residues are composed of seeds,65.9 p.c. and skins 31.10 p.c. The seeds and skins when extracted with ether gave 17.06 p.c.of oil but when extracted with carbondisulphide only 12.13 p.c. The seeds alone yielded 16 p.c.of oil. The oil from the seeds and skins was of an intense red color while that of the seeds was of a straw-yellow color. The oil extracted from the seeds and skins showed the same constants as the oil obtained by Battaglia(1901),who obtained the oil with a pressure of 500 atm.

The following summary records the constants of the oil.

Specific gravity	0.9244
Thermic index	75.75
Saponification number	189.45
Acid number	1.823
Oleic acid	0.09165
Volatile acid	0.2
Iodine number	87.7

The following analysis of the residues of the residues freed from skins,shows that nitrogen,phosphorus and calcium increase in the isolated seeds while potassium diminishes.

Average p.c. of the residue.	Average p.c. of ash.	Average p.c. of acids.	Average p.c.of ash.
6.99 p.c.	----- p.c.	8.95 p.c.	------p.c.
4.11 p.c.	----- " "	4.02 " "	------" "
0.7755 "	18.87 " "	0.5457 "	13.57" "
0.058" "	1.44 " "	0.0299 "	0.72 "
1.0185 "	------	1.6496 "	-----

	Average p.c. of residue.	Average p.c. of ash.	Average p.c. of seeds.	Average p.c. of ash.
Residue of ash insol. in HcL.	------p.c.	13.34p.c.	------p.c.	10.75p.c.
Fe_2O_3: Al_2O_3	0.2856" "	6.95" "	0.3302" "	8.22" "
CaO	0.2926" "	7.1194"	1.2181" "	30.30" "
MgO	0.3528" "	8.58 "	0.1656" "	4.12" "

The analysis of the dried residues and seeds was as follows:-

	Seeds and skins	Seeds
Fatty substances sol.in ether	17.06p.c.	24.38p.c.
" " " " C_2S	12.67" "	-----" "
" " " " pet.ether	-----" "	23.65" "
Total nitrogen	3.65" "	4.42" "
Nit.substances(factor 6.25)	22.84" "	27.63" "
Digestible nit.sub.(gastric)	2.415 "	2.80" "
Equivalent of album. sub.	15.10" "	17.54" "
Digestible nit.substances (pancreatic)	1.70" "	2.52" "
Cellulose(sol.in Schw.reagent)	22.43" "	13.63" "
Lecithin	20.47" "	0.56" "
Equivalent of nit.sub.	10.65" "	15.75" "

The authors conclude that the oil after extraction with carbon bisulphide can be used in the soap industry and the fat-free residues as fodder and fertilizer.

Willstaetter,R.und Escher. 1910.

Ueber den Farbstoff der Tomate.

Zeitsch.fuer Physiol.Chem.,64,p.47.

The authors extract the coloring matter with carbon bisulphide from canned tomatoes and obtain microscopic prisms of lycopin with a small amount of carotin.They conclude that lycopin,the coloring matter of tomatoes,and carotin have the same molecular formula but are not identical. The solutions of lycopin in carbon disulphide have a bluish-red color while carotin yields a reddish-brown solution. Lycopin has a melting point of 168°-169° and is less soluble than carotin in ether,alcohol,carbon disulphide and light petroleum. A dilute alcoholic solution has two bands: 510-499,and 480-468. The carbon bisulphite solution has two absorbtion bands,one in the green and one in the blue.Lycopin absorbs oxygen much more readily than does carotin. It absorbs to the extent of 32.5 p.c. in ten days while carotin absorbs 0.025 p.c. in the same time. When carotin absorbs oxygen an odor of violet root is noticed,while this odor is absent during the lycopin absorbtion of oxygen.

With the halogene,lycopin forms a diiodide, $C_{40}H_{52}I_2$,and a bromide $C_{40}H_{44}Br_{25}$. The latter softens at 148° and decomposes at 174°. Carotin yields a diiodide which melts at 136° and a bromide which decomposes at 174°. Xanthophyll yields a similar bromide $C_{40}H_{40}Br_{22}$.

----- 1910.

Tomatenpulver.

Nachrichtenblatt f.d.Zollst,1910,No.1.(Pharm.Centrh. 51,p.674).

The author records the analysis of tomato powder put up in tablet form.

Bacon,R.F.and P.B.Dunbar. 1911.

Changes taking place during the spoilage of tomatoes and methods for detecting spoilage in tomato products.

U.S.Dept.Agric.Bureau of Chem.Cir.No.78,pp.15.

The authors conclude that good tomato products are characterized by their citric acid,and invert sugar content,but not oxalic,tartaric or malic acids. During decomposition of tomatoes at high temperatures butyric acid is a common decomposition product of the sugars,while at lower temperature acetic,lactic and alcoholic fermentation products predominate.

Nitrogenous substances produce ammonia. Citric acid is also decomposed. The authors propose to use these facts as a basis for determining spoilage and give methods for the determination of the acids. In addition the authors have made a detailed study of the behavior of lactic,malic,and tartaric acids toward oxidizing agents.

Monte,N. 1911.

Ueber die Anwesenheit von Glutaminsaere in Tomatenkonserven.

Staz.Sper.Agrar.Ital.,44,p.813. (Zeitsch.fuer Untersuch.der Nahr.und Genussmittel,24,p.248.

The author states that 80 g.of glutaminic acid were isolated from 60Kg.of tomato conserves.

Ricciardelli,R. 1911.

Cholera und Tomate.

Boll.Chim.Farm.,50,p.573. (Zeitsch.fuer.Untersuch. der Nahr.und Genussmittel,24,p.250.)

The author states that tomatoes contain 90 p.c. of water,3.73 p.c.of glucose,0.81 p.c.of citric acid, traces of oxalic,malic,and oxalic acids,some protein, fat,dry substances and ash. The acid content makes the tomatoes useful as a prophylactic against cholera.

Albanarg. 1912.

Analise dei frutti di pomidoro.

Boll.Chim.farm.51,p.224. (Ab.Am.Chem.Soc.,6,p.3478.)

"Water 93.5 p.c.of fresh fruit;N-containing substance 1 p.c.,greater part of which is insol. in water(0.95 p.c.);substance free from N,0.5 p.c.; grease,0.20 p.c.;carbohydrates,3.6 p.c.;insol.organic material,1.69 p.c.; insoluble inorganic material,1.69 p.c.; insol.inorganic material,0.11 p.c.; total ash

0.74 p.c.;of which 0.12 p.c. is Ca_3PO_4. To neutralize free acid in aq.ext.from 2584 g.of fresh tomatoes, 187.6 cc.N NaOH soln.were required. Acids in fresh fruit are malic 0.48 p.c.,citric,0.09 p.c.,oxalic 0.001 p.c.,tartaric and succinic,traces. The acids are present in fruit combined with bases. In ash,in addition to alkalies and alk. earths,is found H_3PO_4, silicic acid and Fe in both organic and inorganic combinations".

Koena,L.J. 1912.

Tomato Seed Oil.

Daily Consular and Trade Reports,72,p.1228.

Quoting from a French magazine,the author,U.S. Consul in Florence,Italy,relates that 84,000 of tomatoes are said to have yielded 600 tons of oil,but does not find the oil in the local market. The oil is classified chemically as a dry-seed oil like co seed oil,and according to report can be used in al industries where cottonseed or similar oils are used.

---------- 1912.

Tomato Seed Oil.

L'Agr.Commercial,-p.-(Oil,Paint and Drug Report,p.36 Ab.Am.Chem.Soc.,7,p.268.)

"Fresh tomatoes contain about 4 p.c.of skin and 11 p.c.of seeds. Dried seed yields 12-13 p.c.oil(extd. with CS_2). Seeds separated from skins by means of fans yield 16 p.c.oil,density 15° 0.9244,saponification no. 189.45,acid no. 1.823,volatil acids 0.2,iodine no. 87.7. Itbis a semi-drying oil.

Duggar,B.M. 1913.

Conditions affecting the Development of Lycopin in the Tomato.

Science 37,p.378.

"Willstaetter and Escher have shown that the red pigment of the tomato(lycopin,solanorubin) and carotin(derived from the carrot)are isomeric compounds,readily distinguishable by their physical proportion. In the ripening tomato both lycopin and carotin occur. An experimental study of the effects of various conditions upon ripening demonstrates that while carotin is developed under conditions of growth differing widely,lycopin is formed only within a limited range of metabolic activity. Temperature and oxygen supply are two of the factors indirectly limiting lycopin development. In yellow varieties of the tomato "carotin" only is found,and in red varieties lycopinformation is precluded by high temperature, yellow fruite resulting. Irreversible effects are not produced by heat. Red tomatoes seem to contain a factor for redness superimposed upon the factor or factors for yellow,and in this conclusion is borne out by breeding experiments."

Approved Edward Kremers

Prof. of Pharm. Chemistry