ISHS Abstract Book

14th ISHS Symposium on the Processing Tomato

6-9 March 2016
Santiago, Chile

www.worldtomatocongress.cl
Welcome to Santiago, Chile

1989 – 2016

27 years of fruitful collaboration between Science and Industry with the purpose of looking at the future.

When the first World Processing Tomato Congress was held in Avignon in 1989, tomato science and industry pioneered the creation of an institutional framework for dialogue and exchange that was, back then, called "multi-disciplinary and participative" management by organizing it in tandem with the 3rd ISHS Symposium on Processing Tomato. Since then, this effective and fruitful cooperation between Science and Industry has become established and we are now proud to welcome you to the 14th ISHS symposium on the Processing Tomato, organized alongside the 12th World Processing Tomato Congress.

Our call for papers attracted 49 abstract submissions from 18 different countries. This confirms the keen interest and enthusiasm the scientific community has for research in the fields of processing tomatoes. The ISHS symposium program has been arranged into 4 oral sessions centered on the following major topics: "Processing efficiencies coping with cost increments", "Breeding as a tool for optimizing productivity and fruit quality", "Optimizing plant nutrition and water management", "Planning and IPM management", and a poster session for one-to-one discussions with the research authors.

Full papers for the majority of the oral and poster presentations will be collated in a special issue of Acta Horticulturae which can be ordered later directly from ISHS.

We would like to thank the presenters, session chairs and members of the Scientific and Organizing Committees for making this event possible and all attendees for participating in these sessions. We also want to acknowledge Kagome and Nunhems Vegetable Seeds for funding the registration costs of respectively two and one promising scientists from South America who otherwise would have been unable to attend the symposium and present their research.

Our aim is to stimulate discussion and foster new collaborative ventures to ensure a bright future for the tomato processing industry. We hope you will find the event both interesting and enjoyable.

The Symposium Convenors
Cosme Argerich, Montaña Cámara & Maria Teresa Pino
Symposium Scientific Committee

Co-Conveners:
Cosme Argerich (INTA, La Consulta, Argentina)
Montaña Cámara Hurtado (UCM Madrid, Spain)
María Teresa Pino (INIA, Santiago, Chile)

Scientific Committee:
Adriano Battilani (CER, Bologna, Italy)
Diane Barrett (UC Davis, USA)
Carlos Campillo Torres (Cicytex, Spain)
Antonio Casana (Solana Spa, Italy)
Liz Mann (APTRC, Australia)
Gene Miyao (UC Davis, USA)
Luca Sandei (SSICA, Parma, Italy)
Gwen Young (Kagome Inc, USA)

Congress secretariat:
Sophie Colvine (WPTC, France)

Special financial contribution from

KAGOME

nunhems
# Table of Contents

Welcome 1  
Symposium Scientific Committee 2  
Index 3  
Symposium program 4  
List of abstracts 7  
Abstracts 10  
Presentation of ISHS 59
Symposium Program

N.B: This program is correct at the time of printing but subject to minor changes, depending on speaker availability and unforeseen circumstances. Please refer to notice boards and oral announcements during the congress for updated information.

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00 - 10:00</td>
<td>Opening Session (joint with congress).</td>
</tr>
<tr>
<td>10:00 - 10:30</td>
<td>Coffee break.</td>
</tr>
<tr>
<td>10:30 - 12:00</td>
<td>World Economics and Food Challenges (joint with congress).</td>
</tr>
<tr>
<td>12:00 - 12:40</td>
<td>World Tomato Production (joint with congress).</td>
</tr>
<tr>
<td>12:40 - 13:15</td>
<td>Big Data Solution Challenges for Sustainable Agri-Food Supply (joint with congress).</td>
</tr>
<tr>
<td>13:15 - 14:00</td>
<td>Lunch.</td>
</tr>
<tr>
<td>14:15 - 17:00</td>
<td>ISHS Session 1: Processing Efficiency Coping With Cost Increments.</td>
</tr>
<tr>
<td></td>
<td>Chairs:</td>
</tr>
<tr>
<td></td>
<td>Diane Barrett (University of California, Davis, USA) &amp; Luca Sandei (SSICA, Italy).</td>
</tr>
<tr>
<td></td>
<td>Invited conference:</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract K1</strong>: Improving resource efficiency in tomato processing. Ricardo Amon (University of California, Davis, USA).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S1-1</strong>: Factors affecting the loss of consistency during the concentration of juice to paste and consistency changes during paste storage. Diane Barrett (University of California, Davis, USA).</td>
</tr>
<tr>
<td>15:15 - 15:45</td>
<td>Coffee break.</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S1-2</strong>: Rapid characterization of processed tomato purees using mid-infrared spectroscopy. Sylvie Bureau (INRA, France).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S1-3</strong>: Obtaining tomato paste enrichers using tomato byproducts. Crespo Bermejo Abel (CTAEX, Spain).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S1-4</strong>: Factors affecting consumer’s acceptance towards Spanish tomato products: a preliminary study on gazpacho soup. Virginia Fernandez Ruiz (University Complutense Madrid, Spain).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S1-5</strong>: Innovation in industrial tomato sector in Algeria. Amel Bouzid (CREAD, Algeria).</td>
</tr>
<tr>
<td>17:00 - 18:30</td>
<td>ISHS Poster Session &amp; Award Ceremony (joint with congress).</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>9:00 - 12:00</td>
<td>ISHS Session 2: Breeding as a Tool for Optimizing Productivity and Fruit Quality.</td>
</tr>
<tr>
<td></td>
<td>Chairs: Gwen Young (Kagome, USA) &amp; Montaña Camara (University Complutense Madrid, Spain).</td>
</tr>
<tr>
<td></td>
<td>Invited conference:</td>
</tr>
<tr>
<td></td>
<td>Abstract K2: Can the challenges of climate-induced yield reduction be met with new breeding technology? David Francis (Ohio State University, USA).</td>
</tr>
<tr>
<td></td>
<td>Abstract S2-1: Evaluation of volatile and non-volatile taste and flavour compounds of some Italian tomato cultivars throughout processing. Luca Sandei (SSICA, Italy).</td>
</tr>
<tr>
<td></td>
<td>Abstract S2-3: Nutritional quality of orange tomatoes for fresh consumption and processing products. Iris Edith Peralta (UN Cuyo, Mendoza, Argentina).</td>
</tr>
<tr>
<td></td>
<td>10:30 - 11:00 Coffee break.</td>
</tr>
<tr>
<td></td>
<td>Abstract S2-4: Claims related to lycopene and olive oil as functional ingredients in tomato food products: Salmorejo. Montaña Cámara (Universidad Complutense de Madrid, Spain).</td>
</tr>
<tr>
<td></td>
<td>Abstract S2-5: Exploring the whole tomato metabolites through metabolomics approaches. Daisuke Shibata (Kyoto University, Japan).</td>
</tr>
<tr>
<td></td>
<td>Abstract S2-6: Antiplatelet effect of fresh tomato, tomato paste and pomace. Rosío Rodríguez Azúa (CEAP, Chile).</td>
</tr>
<tr>
<td>12:00 - 14:00</td>
<td>Lunch.</td>
</tr>
<tr>
<td>14:00 - 17:30</td>
<td>ISHS Session 3: Optimizing Plant Nutrition and Water Management.</td>
</tr>
<tr>
<td></td>
<td>Chairs: Gene Miyao (UC Davis, USA) &amp; Liz Mann (APTRC, Australia).</td>
</tr>
<tr>
<td></td>
<td>Invited conference:</td>
</tr>
<tr>
<td></td>
<td>Abstract K3: The challenge of nutrition management of processing tomatoes in an era of rising yield expectations. Tim Hartz (University of California, Davis, USA).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-1: Evaluation of different fertiliser programmes and measures of nitrogen plant status for the guidance of plant nitrogen fertilization in a processing tomato on commercial farms. Carlos Campillo (CICYTEX, Spain).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-2: Managing nitrogen fertiliser and irrigation to reduce nitrous oxides emissions is a win for the environment, your health and farm productivity. Liz Mann (APTRC, Australia).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-3: Evaluating water status in processing tomato using combined information from different sensors. Juan Ignacio Macua (INTIA, Spain).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-4: Development of an efficient water management system in a processing tomato commercial farms. Carlos Campillo (CICYTEX, Spain).</td>
</tr>
<tr>
<td></td>
<td>16:00 - 16:30 Coffee break.</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-5: Simultaneous effect of mycorrhizae and water supply on yield formation of processing tomato. Lajos Helyes (Szent István University, Hungary).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-6: Sub-surface Drip Irrigation with Gyp-Flo in Processing Tomatoes. Liz Mann (APTRC, Australia).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-7: Seasonal and irrigation effect on yield parameters and soluble solids content of processing cherry tomato. Péter Szuvandzsiev (Szent István University, Hungary).</td>
</tr>
<tr>
<td></td>
<td>Abstract S3-8: Characterization of the water needs of tomato for processing in Extremadura (Spain). Jose Luis Llerena (CTAEX, Spain).</td>
</tr>
<tr>
<td>Evening</td>
<td>Gala dinner.</td>
</tr>
</tbody>
</table>
**WEDNESDAY MARCH 9**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30 - 10:30</td>
<td>ISHS Session 4: Planning and IPM Management.</td>
</tr>
<tr>
<td></td>
<td>Chairs: Cosme Argerich (INTA, Argentina) &amp; Carlos Campillo (CICYTEX, Spain).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S4-1</strong>: Management of powdery mildew (<em>Oidiopsis sicula</em>) in Central California. Tom Turini (UCCE Fresno County, USA).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S4-2</strong>: Tomato powdery mildew – challenging problem for researchers, breeders and growers. Ales Lebeda (Palacký University, Czech Republic).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S4-3</strong>: Thrips Management in Processing Tomatoes and Influence on Tomato spotted wilt virus Symptom Incidence in Central California. Tom Turini (UCCE Fresno County, USA).</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract S4-4</strong>: Modelling of agricultural and industrial planning in the tomato processing industry using mathematical programming. Cleber Rocco (Unicamp, Brazil).</td>
</tr>
<tr>
<td>10:30 - 11:00</td>
<td>Coffee break.</td>
</tr>
<tr>
<td>11:00 - 12:30</td>
<td>Motivational speech: Alive! (joint with congress).</td>
</tr>
<tr>
<td>12:30 - 13:00</td>
<td>Closing session (joint with congress).</td>
</tr>
<tr>
<td>13:00 - 14:30</td>
<td>Light buffet lunch.</td>
</tr>
</tbody>
</table>
## Oral presentations

<table>
<thead>
<tr>
<th>ABSTRACT NUMBER</th>
<th>ABSTRACT TITLE</th>
<th>PRESENTING AUTHOR</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>Improving resource efficiency in tomato processing.</td>
<td>Ricardo Amon</td>
<td>10</td>
</tr>
<tr>
<td>S1-1</td>
<td>Factors affecting the loss of consistency during the concentration of juice to paste and consistency changes during paste storage.</td>
<td>Diane Barrett</td>
<td>10</td>
</tr>
<tr>
<td>S1-2</td>
<td>Rapid characterization of processed tomato purees using mid-infrared spectroscopy.</td>
<td>Sylvie Bureau</td>
<td>12</td>
</tr>
<tr>
<td>S1-3</td>
<td>Obtaining tomato paste enrichers using tomato by products.</td>
<td>Bermejo Abel Crespo</td>
<td>13</td>
</tr>
<tr>
<td>S1-4</td>
<td>Factors affecting consumer's acceptance towards Spanish tomato products: a preliminary study on gazpacho soup.</td>
<td>Virginia Ruiz</td>
<td>14</td>
</tr>
<tr>
<td>S1-5</td>
<td>Innovation in industrial tomato sector in Algeria.</td>
<td>Amel Bouzid</td>
<td>15</td>
</tr>
<tr>
<td>K2</td>
<td>Can the challenges of climate-induced yield reduction be met with new breeding technology?</td>
<td>David Francis</td>
<td>17</td>
</tr>
<tr>
<td>S2-1</td>
<td>Evaluation of volatile and non-volatile taste and flavour compounds of some Italian tomato cultivars throughout processing.</td>
<td>Luca Sandei</td>
<td>18</td>
</tr>
<tr>
<td>S2-2</td>
<td>Traditional Andean tomatoes: agronomic performance, fruit nutritional quality and potential for alternative processing.</td>
<td>Pablo Asprelli</td>
<td>19</td>
</tr>
<tr>
<td>S2-3</td>
<td>Nutritional quality of oranges tomatoes for fresh consumption and processing products.</td>
<td>Iris Edith Peralta</td>
<td>20</td>
</tr>
<tr>
<td>S2-4</td>
<td>Claims related to lycopene and olive oil as functional ingredients in tomato food products: Salmorejo.</td>
<td>Montaña Camara</td>
<td>21</td>
</tr>
<tr>
<td>S2-5</td>
<td>Exploring the whole tomato metabolites through metabolomics approaches.</td>
<td>Daisuke Shibata</td>
<td>22</td>
</tr>
<tr>
<td>S2-6</td>
<td>Antiplatelet effect of fresh tomato, tomato paste and pomace.</td>
<td>Rosío Rodríguez Azúa</td>
<td>22</td>
</tr>
<tr>
<td>K3</td>
<td>The challenge of nutrition management of processing tomatoes in an era of rising yield expectations.</td>
<td>Tim Hartz</td>
<td>23</td>
</tr>
<tr>
<td>S3-1</td>
<td>Evaluation of different fertiliser programmes and measures of nitrogen plant status for the guidance of plant nitrogen fertilization in a processing tomato on commercial farms.</td>
<td>Carlos Campillo</td>
<td>24</td>
</tr>
<tr>
<td>S3-2</td>
<td>Managing nitrogen fertiliser and irrigation to reduce nitrous oxides emissions is a win for the environment, your health and farm productivity.</td>
<td>Liz Mann</td>
<td>26</td>
</tr>
<tr>
<td>S3-3</td>
<td>Evaluating water status in processing tomato using combined information from different sensors.</td>
<td>Juan Ignacio Macua</td>
<td>27</td>
</tr>
<tr>
<td>S3-4</td>
<td>Development of an efficient water management system in a processing tomato commercial farms.</td>
<td>Carlos Campillo</td>
<td>28</td>
</tr>
</tbody>
</table>
### Posters on Crop production

<table>
<thead>
<tr>
<th>ABSTRACT NUMBER</th>
<th>ABSTRACT TITLE</th>
<th>PRESENTING AUTHOR</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1-1</td>
<td>Response of tomato plants to potassium fertilization under greenhouse in arid conditions.</td>
<td>Abdulrahman Almoshileh</td>
<td>37</td>
</tr>
<tr>
<td>P1-2</td>
<td>Processing tomato cultivation in South Korea.</td>
<td>Choon Gil Kang</td>
<td>37</td>
</tr>
<tr>
<td>P1-3</td>
<td>The use of foliar applications of abscisic acid (ABA) to reduce Blossom End Rot (BER) in processing tomatoes.</td>
<td>Patrick Smith</td>
<td>38</td>
</tr>
<tr>
<td>P1-4</td>
<td>A focus on high-lycopene tomato cultivars: horticultural performance and phytochemical profile.</td>
<td>Lajos Helyes</td>
<td>39</td>
</tr>
<tr>
<td>P1-5</td>
<td>New glass fertiliser for tomato crops to reduce enviromental impact.</td>
<td>Rosa de la Torre</td>
<td>40</td>
</tr>
<tr>
<td>P1-6</td>
<td>Application of VIS-NIR reflectance spectra for estimating soluble solid- and lycopene content of open field processing tomato fruit juice from irrigation and mycorrhizae treatments.</td>
<td>Péter Szuvandzsiev</td>
<td>41</td>
</tr>
<tr>
<td>P1-7</td>
<td>Climatic variability in Extremadura (Spain) for the processing of tomato.</td>
<td>José Luis Llerena</td>
<td>42</td>
</tr>
<tr>
<td>P1-8</td>
<td>Evolution of tomato cultivation in Extremadura, Spain 2001-2014.</td>
<td>José Luis Llerena</td>
<td>43</td>
</tr>
<tr>
<td>P1-9</td>
<td>Early warning system to control Alternaria alternata in the Chilean tomato paste industry.</td>
<td>Susana Arredondo</td>
<td>44</td>
</tr>
<tr>
<td>P1-10</td>
<td>Bacterial Canker: Strategies to Limit Losses in Michigan, United States.</td>
<td>Mary Hausbeck</td>
<td>45</td>
</tr>
<tr>
<td>P1-11</td>
<td>Evaluation of the acybenzolar-s-methyl effect, alone or combined with azoxystrobin, on the control of blossom end root in tomato industry cultivated in two different water regimes.</td>
<td>Aniello Crescenzi</td>
<td>46</td>
</tr>
<tr>
<td>P1-12</td>
<td>Remotely piloted aircraft for agricultural spraying in high value crops.</td>
<td>Ken Giles</td>
<td>47</td>
</tr>
</tbody>
</table>
P1-13 Influence of sheep wool as organic fertilizer in processing tomato. Elena Ordiales Rey 48

P1-14 Egyptian broomrape eradication effort in California: A progress report on the joint effort of regulators, University, tomato growers and processors. Gene Miyao 49

P1-15 Quality and yield of tomato as influenced by mulch and tillage methods. Ramendra Singh 50

P1-16 Incidence of blind transplants of processing tomato from primed seeds. Warley Nascimento 51

P1-17 The effect of industry tomato seeds assessment using computerized image analysis. Warley Nascimento 51

Posters on Processing & Products

<table>
<thead>
<tr>
<th>ABSTRACT NUMBER</th>
<th>ABSTRACT TITLE</th>
<th>PRESENTING AUTHOR</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2-1</td>
<td>Biogas productivity potential of agro-industrial biomasses, generated by the tomato processing industry</td>
<td>María Eugenia Martínez</td>
<td>52</td>
</tr>
<tr>
<td>P2-2</td>
<td>Correlation between NTSS, squeezed brix and brix in cold break tomato paste.</td>
<td>Siva Subramanian</td>
<td>53</td>
</tr>
<tr>
<td>P2-3</td>
<td>The technological observatory for the tomato industry.</td>
<td>José Luis Llerena</td>
<td>54</td>
</tr>
<tr>
<td>P2-4</td>
<td>Tomato bio-based lacquer for sustainable metal packaging.</td>
<td>Rosa de la Torre</td>
<td>55</td>
</tr>
<tr>
<td>P2-5</td>
<td>Mechanism of antiplatelet action induced by guanosine from tomatoes (Solanum lycopersicum).</td>
<td>Eduardo Fuentes</td>
<td>56</td>
</tr>
<tr>
<td>P2-6</td>
<td>Obtaining enriched fried tomatoes sauce using tomato byproducts.</td>
<td>Bermejo Abel Crespo</td>
<td>57</td>
</tr>
</tbody>
</table>
A whole systems approach is needed to estimate and analyze the technical potential to increase energy efficiency and conserve water at industrial tomato processing facilities. A Water Energy Nexus (WEN) assessment methodology was developed to integrate the use of national standards and public-domain tools to enable the WEN assessment method. The WEN assessment methodology utilizes the industrial energy system assessment standards published by the American Society of Mechanical Engineers (ASME) and the Department of Energy (DOE) Industrial Best Practice Tools designed to model the operational performance of steam systems, pumps, compressed air systems, fans and process heat systems. The WEN assessment delivers actionable data to tomato processing facility managers to better understand their current resource efficiency and quantify the benefits of potential resource efficiency measures. These methods were first developed and used during the 2012 production season at the Campbell Soup Company, Dixon, California facility. In 2013, the WEN assessment methods were further tested at the Ingomar Tomato Company, Los Banos, California facility. In these field studies, UC Davis researchers engaged processing facility managers to identify the supply-side and the demand-side of the WEN relationship. An ASME energy system assessment (ESA) was conducted to establish the operational efficiency of the steam system and to identify thermal energy resource efficiency measures (REMs). Inspections were conducted at each unit operation to collect name plate data, measure water flow rates, measure pipe inlet diameters, outlet diameters, and lengths, catalogue elbows and valves, and record system power demand. ASME pumping system ESAs were conducted to establish operational plant efficiency (OPEs) at both supply-side and demand-side WEN unit operations (WEN Points). Researchers utilized the DOE Steam System Assessment Tool (SSAT) and the DOE Pumping System Assessment Tool (PSAT) to estimate the operational performance of these energy assets and model cost effective REMs. Ultimately, these data were used to quantify water and energy, along with the water energy intensity, at each processing unit operation. Plant managers achieved electric energy savings by upgrading pumping plant equipment and improving operational efficiencies, at the feed water boiler system and the wastewater pumping systems. Thermal energy savings were achieved by optimizing the steam trap system and installing insulation on pipes and steam valves. Moreover, these data can be used to inform design of novel resource efficiency technologies. For example, medium term REM project, yet to be implemented, integrates the recovery of waste heat from hot “tomato water” sources, the recovery of fresh ground water, and the reduction of wastewater discharge.

### Introduction
Consistency is an important quality characteristic of tomato juice and reconstituted tomato paste. During the concentration of raw tomato juice to paste, losses in consistency and serum viscosity are commonly known to occur. Storage of concentrated paste, and reconstitution of the paste back to juice with water, results in a further reduction in consistency and viscosity. To understand the reasons for this, samples of raw juice, processing intermediates and final paste were collected from an industrial processing plant during normal commercial production, and the final paste was stored for up to one year.
Materials & Methods
Tomato products were sampled on 3 different days over two seasons at the Morning Star processing plant in Williams, California. Hot-break juice was collected after passing through the finishers but prior to any concentration and an 11° Brix concentrate was taken from the second effect evaporator. All samples were diluted with water to 5 °Brix, and analyzed for Bostwick consistency, serum viscosity and pectin content. Bostwick consistencies of reconstituted pastes were measured both immediately after paste production and after storage of up to 12 months. Soluble solids content was determined with an Atago PR32 digital refractometer then additional water was added to dilute the suspension to 5 °Brix. Subsequent dilutions of this same paste during storage were all done with this same final water to paste ratio. Dilution to other °Brix values followed a similar procedure. Bostwick values were determined at 25 ± 0.5 ºC. For serum viscosities and precipitate weight ratios, 30.00 g of the juice samples were centrifuged at 5 ºC for 10 minutes at 14,000 x g in a Sorvall centrifuge. The supernatants were collected then the weights of the pellets determined and the precipitate weight ratios calculated. The viscosities of the supernatants (serum viscosities) were then determined using a Cannon-Fenske type viscometer at 25 ± 0.5 ºC. Pectin analysis followed the procedure described in (Anthon and Barrett, 2008).

Results
Tomato juice consistency decreased throughout the course of juice concentration, with the greatest change occurring early in the process, as the juice was concentrated from 5 to 10 °Brix. This decrease occurred during concentration of both hot- and cold-break juices and was correlated with a decrease in precipitate weight ratio. The loss of consistency during commercial processing was not the direct result of water removal because a sample of this same juice could be concentrated 2-fold in a vacuum oven then re-diluted with no change in consistency or precipitate weight ratio. Total pectin content did not change as the juice was concentrated to paste but the water soluble proportion of the total pectin increased. The greatest increase in pectin solubility occurred late in the process where the evaporator temperature was the highest.

The Bostwick values of stored tomato pastes were more than twice those of the same pastes measured on the day of paste production, indicating a significant loss of consistency during storage. This increase in Bostwick developed primarily during the first month of paste storage at room temperature, and could be slowed down but not prevented if the paste was stored at 4°C. Unlike changes in consistency that occur during paste production, the increase in Bostwick during storage occurred only if the juice was concentrated above 11°Brix. This change was not accompanied by a decrease in the precipitate weight ratio. More significantly, the loss of consistency during storage could be nearly completely reversed if the reconstituted paste was heated to 90°C or above. Optimal heating times for restoring consistency were 30 minutes at 90°C or 12 minutes at 100°C. Heating was much less effective in reversing the loss of consistency that occurred during paste production.

Serum viscosities also decreased during paste storage, but the change in serum viscosity was proportionally smaller than the changes in Bostwick consistency. As with the Bostwick, heating the reconstituted juice under similar conditions restored the serum viscosity. For proper evaluation of the consistency of stored tomato paste it is essential that the reconstituted paste be heated. This might be done during product formulation, when water and other ingredients are typically added to stored paste to create pizza and spaghetti sauces, salsa and other high value products.
Improving quality control of processed tomato could lead to 1) enhance the raw tomatoes quality delivered to plants when price corrections according to quality level is adopted and 2) to optimise the use of raw material by better adapting the processing routes to tomato characteristics, and obtaining the most suitable final product. Mid-infrared spectroscopy (ATR-FTIR) offers the advantages of analysing homogeneous plant materials such as liquids or purees, using a rapid and simple data acquisition, as soon as a calibration with reference measurements for traits of interest has been validated.

The objective of our study was to investigate the accuracy of the mid-infrared spectroscopy to predict internal quality traits in purees of processed tomatoes. In 2014, tomatoes were harvested at different ripening stages, from mid to overripe, in two production areas, south-west and south-east of France, and cultivated with different irrigation practices to take into account the representative fruit variability of tomato cultivated in France. Tomato purees were characterized by both infrared spectroscopy (4000-650 cm\(^{-1}\)) and by reference measurements. The potential of this method coupled with chemometrics based on partial least square (PLS) regressions was assessed for the determination of soluble solids content (SSC), titratable acidity (TA), dry matter, glucose, fructose, malic acid and citric acid. The performance of this method was evaluated by the coefficient of determination (R\(^2\)) and the root mean square error of prediction (RMSEP).

Mid-infrared spectroscopy showed a good ability to estimate not only SSC (error of 3.5%), TA (error of 4.4%) and dry matter (4.3%) but also individual sugars (Glucose 4.7% and Fructose 7%) and Citric acid (7%). For malic acid, the high error of prediction (14%) was probably in relation with its low level in the studied tomatoes.

This trial has been repeated in 2015 in order to evaluate the effect of harvesting year on fruit quality and mid-infrared performance. In addition, this year, processed samples and new quality traits such as texture-related parameters of tomato puree have been added to the experimental design, in order to test the ability of mid-infrared spectroscopy to predict such quality parameters on processed products.

The infrared spectroscopy allows 1) a considerable reduction of time of analysis compared to the current methods, and 2) a more detailed prediction of parameters than only global measurements such as SSC or dry matter. As it is already the case for other food industries, we believe that mid-infrared spectroscopy and appropriate models specifically developed for processed tomatoes such as those developed in this study may play a role for the improvement of quality control in tomato industry.
The industrial process involved in the manufacture of tomato concentrate generates some 4% of by-products including peel and seeds which is currently destined for the manufacture of animal feed. This study demonstrates a method of utilizing tomato by-products to obtain new Intermediate Food Products (IFPs) in such a way that a mixture of 20% of fresh peel and seeds crushed mixed with tomato juice of minimum 20/22 °Brix, when concentrated, will deliver positive physicochemical and sensorial results adding value to the primary and final products of the tomato production process. This is due to the elevated concentrations of fibre and lycopene.

Introduction
Extremadura is responsible for 90% of the tomato production and processing in Spain. Most of the surface area used in its cultivation and almost all of the processing takes place in Extremadura. It has been estimated that approximately 4% of the total weight of the fruit is currently destined for use as by-products (peel and seeds). The by-products produced during this process are referred to as secondary raw materials. Government regulation 96/25/EC, currently allows for «the reuse of tomato pulp obtained from the pressing of the tomato Solanum lycopersicum Karst» for animal feed.

In summary, the purpose of the study is to obtain an Intermediate Food Product (IFP) using the by-products of peel and seed derived from the manufacturing process, to produce a marketable standalone product capable of adding physicochemical value to food products.

Methods
The peels and seeds obtained as by-products after the sieving of crushed tomatoes, with the enzymes having been previously inactivated during the preparation of tomato concentrate, is used both fresh (without drying) and partially dried in an oven with a moisture content of 37.7% for the development of IFPs. The peels and seeds were then ground and packed in sterile and microbiologically stable bags (heat treated to 100°C for 114 mins using an autoclave).

The samples produced returned values of F0 de 0.17 and 0.72 min. respectively. In both cases, the development of an IFP using a mixture of between 5-50% of peel and seeds either fresh or dried previously crushed in to a HOT tomato concentrate, in order to select the optimum mixing ratios relating to such organoleptic factors as general appearance, colour, odour, flavour and texture. In conclusion, it was determined that the optimal mixing proportions correspond to 20, 30 and 50% of peel and seeds to concentrate.

Once the optimum mixing ratios have been determined, the second phase is the mixing of the pre-established proportions of ground peels and seeds with tomato juice, which has been obtained from the primary steps of concentrate process. The mixture then undergoes a final process of concentration in evaporators of up to 20/22 °Brix. This enables the evaluation of the technological difficulty of the process.

The final phase was to conduct a triangular sensory test to determine the differences between the IFPs developed and the typical tomato concentrate of 20/22 °Brix, to determine those characteristics that add sensorial value and are suited to the development of the end product.
Results

The use of partially dehydrated peels and seeds ground for the development of IFPs proved to be inadequate giving a fibrous appearance and unusual taste, while the fresh peels and seeds mixture provided positive results consistent with the standard tomato paste designated as the control.

The production of IFPs using a mix of fresh peel and seeds blended with tomato juice and later concentrated to 20/22 °Brix will be cost effective as long as the quantity of the by-product does not exceed 30%, the ideal mixture as indicated by sensorial tests being 20%. Mixtures of 50% peel and seed with tomato juice in addition to being unacceptable in sensorial tests were also unable to achieve concentrations greater than 17°Brix due to the thickness of the tomato juice.

Physicochemical analysis of the final product mixed with the peels and seeds revealed an augmentation of Lycopene and fibre levels and a higher percentage of mono and polyunsaturated fats.

Conclusion

This study has demonstrated the viability of obtaining a distinct and enriched tomato product through the reprocessing of the same peels and seeds used in the initial tomato processing activity, which can then be mixed with the tomato juice prior to its concentration. The present study opens several commercial options for the tomato industry from reprocessing and recycling of their own by-products to the development of new standalone products, which can be used as natural enriching agents.

S1-4  FACTORS AFFECTING CONSUMER’S ACCEPTANCE TOWARDS SPANISH TOMATO PRODUCTS: A PRELIMINARY STUDY ON GAZPACO SOUP.

Oral

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Introduction

The consumption of “gazpacho” a special cold Spanish tomato soup was initially linked to food eaten at home but nowadays its utilization is increasing being currently one of the most consumed cold tomato soup by the Spanish population. The evaluation of the products by consumers is linked to the consumer’s own preferences, mainly determined by intrinsic properties of the product but also for other personal, cultural, socioeconomic environmental, demographic and marketing. So, the quality of a product is dynamic and changes over time, fashion and consumer. The study of consumer-specific factors by sensory evaluation can provide key information on the development of new products. In this study we performance the sensory analysis of five commercial gazpacho sauces of different brands presenting differences in its composition that directly affects its sensory characteristics. The purpose of this work is to understand the factors affecting the consumer acceptance of tomato soup product, Spanish gazpacho, through sensory evaluation (consumer hedonic test) and the potential correlation with its composition as it is shown in the label.

Material and Methods

Products: consumers have evaluated 5 different Spanish commercial brands of Gazpacho soup. From each product more than eight units of the same batch were obtained for the study.
Participants: The study involved young consumers from different countries and consisted of 60% females and 40% males (ages ranging from 20 to 35), 95% of them are considered as gazpacho soup habitual consumers when they are in Spain. They tasted the 5 samples performing the test with a 9 hedonic scale. Consumer’s data concerning sex, age, nationality and frequency of consumption of gazpacho were recorded previously to the tests.

Consumers test: For sensory analysis, a panel involving of 60 consumers was presented with five coded samples of a fix amount of gazpacho soup in a blind test. Each consumer rated overall liking with 9-point hedonic scale anchored with “Like extremely” and “Dislike extremely” at either end and with a neutral point of “Neither like nor dislike” in the middle. Serving order was randomly assigned to each consumer. Consumers were asked to rinse with water between samples. Previous information concerning the products or the experiment was not given. Consumer tests were generally conducted in classrooms, but in all cases complying with minimum requirements such as lighting and isolation from noise and odours. Samples were prepared before each test. In each test and for each consumer, order of presentation of samples was randomly assigned in order to minimize learning bias.

Statistical analysis: All analyses were performed with Statgraphics Plus version 5.1. and XLSTAT * 1994.

Results
With regards to sensory consumer tests, significant differences on the hedonic ratings of gazpacho studied have been found at 95.0% of confidence level Tukey test. The analysis of information obtained after the application of Multidimensional Analysis of Preference Data of gazpacho attributes will better understand the preferences of these consumers, and anticipate their reactions and their classification in different profiles in order to observe changes in acceptability of products to guide their development and optimization.
Consumers’ acceptance preliminary results show strong variation among commercial products as well as a strong correlation with their nutritional composition. More analyses of other variables linked to consumers’ segments, interest on health issues as well as the estimation of neophobia level are to be performed.

S1-5 INNOVATION IN INDUSTRIAL TOMATO SECTOR IN ALGERIA

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In this paper we will try to explain why some producers of industrial tomato in a same production area even manage to achieve yields of about 80 t/ha per hectare while others fail to reach 50 t/ha.

To understand and explain the difference in yields, a survey was conducted among 150 farmers in the province of Guelma. This area is principally characterized by a high industrial production of tomato due to the installation of the largest cannery in Algeria (Amor Ben Amor canning).

This family company (CAB) has been established in 1984 and it’s a branch of “BENAMOR Group”. CAB employs about 600 people (including 160 permanent employees) and also holds other food sub-activities (milling, semolina, pasta ...). CAB has three processing units: El Fedjoul unit with a processing capacity of 3600 t/day of fresh tomatoes, Bouati unit with capacity 1600 t/day and Ben Azouz unit with a capacity of 2400 t/day.

With a total production capacity of 7600 t/day, CAB absorbs the production of 300 farmers and ensures the production of 45 000 tonnes of double tomato concentrate, which represents 50 % of the country needs.
A multiple regression was used to explain this difference:

Y = F (SV, A, FQ, PP, IS, PC, EX)

Y : Yield  
SV : Seed variety  
A : Area  
FQ : Fertilizer Quantity  
PP : Phytosanitary Products  
IS : Irrigation System  
PC : Previous Crop  
EX : Experience

The results showed that 80 farmers (53.33%) have a yield that exceeds 80 t/ha, 43 farmers have a yield between 40t/ha and 50 t/ha), while the yield of 27 farmers does not exceed 40 t/ha.

The regression results show that farmers who have yields that exceed 80 t/ha are those using hybrid tomato plants, use drip as irrigation system and have wheat as the previous crop. While the other farmers produce themselves their tomato plants from traditional tomato varieties and used aspersion irrigation system.  
The first estimations show that the variables: area, seed varieties, fertilizer quantity, phytosanitary products, irrigation system, previous crop and experience explain 63% of the yield of an hectare industrial tomato.

But the observed Student p-value changes the data because the three variables were not significant at the 5% threshold. These variables are: the area, the fertilizer quantity, phytosanitary products. The lack of significance of these variables means that regardless of the area, the fertilizer quantity and the phytosanitary products used per hectare are same. This can also be explained by the strategy pursued by the company CAB because farmers who are in agreement with CAB are assisted by technicians and engineers from the company, guiding them in similar quantities necessary for production.

Table of regression shows that the use of hybrid varieties of seeds contributes to 45% in the yield of one hectare of industrial tomato, followed by the variable irrigation system (drip) at 16%, the variable previous crop (wheat) with 6.48%, and finally the experience of the farmer with 1.46%.

So our model is as follows: Y= 4.01+0.456 SV+0.1652 IS +0.0665 PC+ 0.0146EX

According to our regression results, we can deduce that neither the fertilizer quantity, or the phytosanitary products or area have an influence on the yield of one hectare of tomato. However, the use of hybrid varieties of seeds, using the drip irrigation system and as wheat as previous crop.

In conclusion we can say that innovation in the irrigation system and the use of hybrid varieties of plants lead to increased yields per hectare, which in turn enable to increase the production of double tomato concentrate and therefore the development of the industrial tomato sector in Algeria.
Plant breeding is poised for a revolution driven by new statistical methods that support prediction and selection based on parentage and DNA sequence variation. At the same time, extreme weather patterns including draught and floods have impacted major production regions in the world. Crop loss resulting directly from abiotic stress is further complicated by the emergence of new plant diseases and pest populations in response to changes in climate and weather. The processing tomato industry has been both impacted by climate and also stands well positioned to leverage new developments in genetics. In the past 18 months the complete genome sequences of over 450 tomato (Solanum lycopersicum) inbred lines, old varieties and wild accessions have been made available in public databases. A further 1,000 varieties and accessions have been characterized with high-density Single Nucleotide Polymorphism (SNP) arrays. The information gleaned from these studies offers insights into selection during domestication and contemporary breeding.

These studies tell us about the past. To fully realize the potential of Next Generation Sequencing technologies and selection methodology for the future, the processing tomato industry can learn from plant and animal improvement efforts that have successfully implemented genomic selection strategies. Features of successful implementation include a commitment to collect objective data, increasing the capacity for biological assessment of key performance characteristics in relevant environments, and improving our ability to balance and value traits. Such efforts could be seed or processing company specific or coordinated between the private and public sector aimed at increasing the ability to model and predict performance. In order to balance production traits (including resistance to biotic and abiotic stress) and processing traits, multi-trait indices (MTI) will need to be developed. MTI weigh traits depending on their net merit and facilitate selection of superior genetic material. In animal breeding economic values are commonly used to develop MTI. For vegetable crops, economic data to value traits are not generally available.

The California Processing Tomato Advisory Board (PTAB) report and the University of California Cooperative Extension (UCCE) statewide variety evaluation trials represent the largest phenotypic datasets available for processing tomato with data collected between 1992 and 2014. Analyses of these data were performed in order to test how traits measured in historical datasets reflect the performance of varieties in the California processing tomato market. Several MTI were developed which represent a first attempt to compare objective trait models that could be leveraged with new approaches to selection in the context of plant breeding programs. Several MTI based on this analysis appear to be more effective in predicting variety success than single trait methods or multi-trait methods previously published. Experience in the context of the Ohio State University (OSU) tomato breeding program demonstrates how trait models can be combined with genomic information to increase gain under selection and predict new hybrid combinations.

The analyses of OSU efforts also emphasize that the focus on multi-generation populations is more important than creating sequence dense data sets, probably due to limited recombination within the context of breeding programs. The lessons learned from the OSU experience reinforce the importance of collecting objective data for important traits and evaluating large populations in relevant environments. The remaining challenge will be to predict which traits, including resistance to abiotic stress, are needed and how to value them for the future.
The Human taste and flavour perception derives from the particular combination of taste and aroma sensations. The four tastes, or rather five, if we consider all the human perceptions (sweet, sour, salty, bitter and umami) are recognized by specific regions of the tongue, while volatiles are perceived by the olfactory nerve endings of the nose.

Many research works established that human taste receptors responds at specific stimulus activated by ratio combination between acids, sugars, lipids, protein together with specific micro molecules (volatile and non-volatile) present in the specific food. A particular challenge for the modern tomato industry will be to satisfy as much as possible the consumer demand in terms of food safety, nutritional facts, new functional compound, and specific hedonistic characteristics of the final products (colour, taste and flavour).

The aim of this work was to start building a specific analytical database able to distinguish both the “taste and flavour molecules” of the tomato products (the pleasant sweet sour relation) putting together volatile and non-volatile elements allowing the selection of more “tasty” and “savoury” fresh matters and hence final products.

With a previous published work, the non-volatile molecules sugars, organic acids, and other “classic” quality parameters have been analysed with particular attention to the amino acidic profile, in order to assess the amino acidic profiles and evaluating any change occurring before and after processing.

The amino acids profile, confirmed that Glutamic acid, g-aminobutyric (GABA) acid, Aspartic acid and Glutamine are the most representative amino acids of both fresh fruit and processed tomato products, according with data reported in literature.

These data showed that glutamic acid is one of the most abundant amino acid, followed by aspartic acid. In particular, glutamic acid is recognized as the best amino acid with a unique taste-potentiating property.

As previously described, the interaction between volatile and non-volatile fraction, affecting the characteristic tomato flavour, involves particularly the amino acidic component, since some of these appears to be the precursor of relevant volatiles in tomato. Tieman et al. reported that 2-phenylethanol and 2-phenylacetaldehyde produced from phenylalanine, while Mathieu et al. showed that (Leu) Leucine and (Ile) Isoleucine are precursors of 2-methylbutanal, 2-methylbutanol, 3-methylbutanal, and 3-methylbutanol.

Of the over 400 volatiles determined, 30 have proved to be the most important compounds contributing to the aroma of tomatoes. Consequently, the tomato taste and flavour is strictly affected by the interaction of the volatile and non-volatile components formed before and after processing.

With regard to the determination of volatile components, the analyses of this research have been carried out with a GC/MS instrument within the range of 35- 400 atomic mass unit. Sampling have been carried out by SPME (solid micro-extraction) and PDMS/Carboxen/DVB exposition (20 min.) The main molecules analysed were Hexanal, 6-Metil-5-epen-2-one, Hexyl acetate, (E)-2-Heptenal, 2-Isobutiltiazole, Geranyl acetone and others.
Through the application of a specific experimental design, four Italian processing tomato cultivars were grown in randomized test plots in experimental field (A.A.S. Stuard) and were processed at SSICA pilot plants into two typical Italian tomato products (Diced and Puree); the main volatile and non-volatile analyses were assessed in the cultivar before and after processing.

This study aims to identify what are the most important molecular parameters (non-volatile and volatile) that can be recognized as “markers of flavour and taste” both in fresh tomato cultivars and in the correspondent processed products. The interaction between these molecules and the evaluation of a data set coming from hedonistic panel test analyses evaluating the same final products obtained will be the next step of this research.

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<th>S2-2</th>
<th>TRADITIONAL ANDEAN TOMATOES: AGRONOMIC PERFORMANCE, FRUIT NUTRITIONAL QUALITY AND POTENTIAL FOR ALTERNATIVE PROCESSING</th>
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<tr>
<td>Oral</td>
<td>P.D. Asprelli1,2*, M. Sance2, E.M. Insani3, R. Asis4, E.M. Valle5, F. Carrari3,6, C. Galmarini1,2, I.E. Peralta2,7</td>
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<td>1 Estación Experimental Agrícola INTA La Consulta, San Carlos, Argentina;</td>
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Tomato provides important nutrients to human diet worldwide. Traditional varieties or land races have been selected by local farmers mainly for fruit quality traits (flavour, aroma, colour, flesh amount and texture, etc.).

A collection of local varieties have been recovered from Andean areas of Cuyo and Northwestern Argentina, and maintained in the Germoplasm Bank of the Agriculture Station of La Consulta INTA, San Carlos, Mendoza. Our goal was to establish associations among agronomic performance, commercial and nutritional fruit qualities, and capacity to adapt to different industrial processes of a collection of Andean tomatoes and commercial cultivars.

For this purpose, different accessions were evaluated: seven local varieties from EEA La Consulta INTA Germoplasm Bank, three commercial cultivars, and as contrasting control a wild species (Solanum pimpinellifolium LA1589). Field comparison of these accessions was done at the Institute of Horticulture (FCA-UNCuyo, Mendoza), using a randomized design with three replicates. In order to evaluate morphological and agronomic traits, thirty-one quantitative traits and thirteen qualitative traits were recorded. Mature red fruits were harvested, immediately frozen with liquid nitrogen, and maintained in ultra-freezer at -80ºC until analyses. Metabolite contents were evaluated by GC- and LC-MS and 1H-MNR, and 175 different compounds were detected. Four different processing procedures were also evaluated for industry and fresh consumption tomatoes. All data were integrated using uni and multiple variable analysis.

Fruit size was inversely correlated with free amino acids content, suggesting a dilution effect. Fruit shape and size partially correlated with sugar and organic acids compounds. Additionally, shape and pericarp thickness associated with organic acids, free amino acids, and aromatic compounds, as well as with pH and juice acidity; although not correlation was found with soluble solids, dry matter or pericarp firmness. Colour intensity of fruit showed a clear association with the increase of few metabolites and the decrease of several aromatic compounds and alcohols. Finally, an interaction between carotenoids amount and different processing procedures was detected, a pattern also related with the evaluated cultivars.
These results reveal that improvements in fruit tomato quality and nutritional value, would be complementary with the selection of agronomic properties, allowing breeding cultivars that better adapt to different industrial procedures and products for specific purposes.

### S2-3 NUTRITIONAL QUALITY OF ORANGES TOMATOES FOR FRESH CONSUMPTION AND PROCESSING PRODUCTS

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<tr>
<td>I.E. Peralta 1,3*, D. Peppi1, M. Sance1, C. Galmarini1,2 and P.D. Asprelli1,2</td>
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In Argentina, traditionally the majority of commercial tomatoes for fresh consumption as well for processed products have red fruits. Although, other fruit color (yellow, purple) are present in the “cherry” types. Nevertheless, tomato orange fruit varieties for direct consumption or for the industry, are not found in the current market.

Our objective was to select genetic materials to generate varieties of different color and non-traditional characteristics of the fruit. Field comparative trials were performed during three cycles (2011-12; 2012-13 and 2013-14) at the Institute of Horticulture (FCA-UNCuyo, Mendoza), allowing to select two varieties with good agronomic performance, productivity and quality of the fruit: (1) determinate growth, with 3-5 fruits per cluster, fruit pear shape with mamelon, orange, jointless; (2) indeterminate growth, with 3-5 fruits per cluster, oval, orange-caqui, jointless or with not functional pedicel articulation. Fruits of the two varieties have good internal and external color, adequate pericarp thickness, homogeneous maturation, and fruits adapted to manual and mechanical concentrated harvest.

Mature fresh fruits of both varieties were characterized by physico-chemical composition, total polyphenols, lycopene and y b-carotene, and antioxidant activity, showing an interesting nutritional conformation and different antioxidant properties. Using mature fruits, a marmalade was produced at the Pilot Processing Industry (FCA-UNCuyo, Mendoza), and its nutritional composition as well as the phytochemical contribution (polyphenols, lycopene and y b-carotene) and antioxidant activity were established. Finally, acceptability of the new product was assessed by a written questionnaire about sensorial qualities (color, flavor, texture, etc.) that was completed by 100 consumers.

The marmalade have a high acceptance and constitute an interesting product with excellent nutritional values that also could cover part of the require antioxidant compounds in human diets. At present, the orange marmalade is commercialized locally by FCA-UNCuyo, Mendoza, with an adequate acceptance by consumers.

Varieties of oranges fruits have excellent nutritional properties and sensorial characteristics for their direct consumption and for processed products which are of industrial interest.
Introduction
Salmorejo is a Spanish cold soup made of tomatoes, extra virgin olive oil, bread crumbs, garlic, vinegar and salt being nowadays exported and found in many establishments from different cities around the world. Tomato products as Salmorejo soup are complex tomato matrices that contain a high level of bioactive compounds as lycopene, and other important ingredients as extra virgin olive oil which has been reported to have many important health benefits.

Food products marketed in the European Union must comply with the following regulations regarding claims on labels: R 1924/2006, R1925/2006, R 116/2010 and R1169/2011. Regulation (EC) 1924/2006 prohibits a food to be promoted as having therapeutic or curative properties and establish the following categories of statements: “nutrition” or “content”; “health claims”; “statements disease risk reduction.” The requirement of the Regulation is that any statement must be based on proven scientific evidence. It applies to nutrition and health claims made in commercial communications, whether in the labeling, presentation or advertising of foods to be delivered as such to the final consumer.

This paper is aimed to review the EFSA current approved nutrition, content and health claims related to lycopene and extra virgin olive oil as ingredients in tomato food products such as “salmorejo” soup to be used on labeling and marketing purposes.

Main Results
Salmorejo is a tomato-based cold soup highly appreciates and consumed in Spain. This product contains high amount of lycopene and significant amount of extra virgin olive oil.

Regarding lycopene, the only authorized claim is the following: “contains natural lycopene” or variations always providing the term “naturally” or “natural” prefix to the statement. In relation to health claims, so far only it has been allowed a relative claim in tomato derivatives corresponding to a tomato concentrate without lycopene which claimed effect is “reduction of platelet aggregation.”

Related to extra virgin olive oil, in terms of permitted claims referred to olive oil, the EFSA has approved the followings: 1. Replacing saturated fats with unsaturated fats in the diet helps keep normal blood cholesterol levels. In this group of unsaturated fatty acids are included monounsaturated fatty acids (as oleic acid) and polyunsaturated. 2. Polyphenols from olive oil contribute to the protection of blood lipids against oxidative stress.

Conclusions
We must emphasize the importance of lycopene and extra virgin olive oil, as key ingredients in tomato products the first for its important health benefits and the later for their nutritional value and significant content of bioactive compounds, such as polyphenols. Following the EFSA requirements further human studies are essential to justify future health claims. In relation to the types of intervention studies necessary to explain the effect, the population should be healthy individuals, and be well-controlled studies (specifying either the control/placebo), and in each case using the markers considered valid by EFSA. This information could be very useful for industry in order to put in value their products as well as design the marketing campaigns.
Finding functional or healthy components in food materials through metabolomics approaches is an emerging research area in food science. The findings will be key to developing new processing methods for functional foods. Tomatoes are known to have at least 5,000 metabolites (ingredients) in which functional or palatable chemicals are likely to be included. However, most of these metabolites are uncharacterized and are not yet available for food research and development.

To explore the whole tomato metabolites, our team is made up of three labs, KAGOME Tomato Discoveries Laboratory, Laboratory of Molecular Function of Food, and Laboratory of Food Quality Design and Development in Kyoto University collaboration with KAGOME CO., LTD. We are engaged in ongoing annotation of metabolites in many cultivars of tomato detected by the-state-of-the-art liquid chromatography-coupled mass spectrometry with bioinformatics approaches. The data of the annotated metabolites are deposited in our metabolite database, and the information about tomato metabolites is used to search for functional components. The tomato metabolite information is also used to develop functional foods, where tomato fruit undergoes food processing treatments, and the quality and palatability of the processed tomato is evaluated. The background and current status of our project will be presented.

Cardiovascular disease (CVD) is the leading cause of death worldwide. Healthy eating is among its preventive measures, especially when consuming fruits and vegetables. In this context it has been shown that tomato (Solanum lycopersicum) presents an antiplateley activity thus decreasing the prevalence of CVDs. In the present study, we evaluated in vitro antiplatelet activity of fresh hybrid industrial tomato (nine hybrids: Apt 410, H 9888, Bos 8066, Sun 6366, AB3, HMX 7883, H 9665, H 7709, and H 9997) and paste. Moreover, in vitro and ex vivo antiplatelet activity of industrial byproduct tomato pomace were also evaluated. The data obtained indicated that tomato has one or more compounds that caused antiplatelet activity. Regular consumption of tomato and its industrial derivatives could be part of a CVD prevention diet.

Three types of samples were evaluated that included fresh tomato, pasta, and tomato pomace. Samples were collected from Sugal Chile Plant in Talca. For the preparation of fresh tomato aqueous extracts, a separation of skin and pulp was performed. Then, small pieces of flesh and skin were macerated. The resulting homogenate was filtered. The aforementioned aqueous extract was lyophilized until the total disposal of water and it was stored in a  – 70 °C freezer until use. Same filtration protocol was followed for the aqueous paste extracts. To prepare the aqueous extracts of pomace, the sample was re-suspended in water and it sonicated, after that it was filtered, lyophilized, and stored as previously described. For the preparation of human platelet suspensions venous blood samples were taken from
volunteers in 3.2% citrate tubes (9:1 v/v) by phlebotomy. After this samples were centrifuged at 240 g for 10 min, and 1mL of platelet-rich plasma (PRP) was taken from each tube for platelet count (in triplicate) in a hematologic counter. The original tubes were centrifuged at 650 g for 10 min to obtain the platelet-depleted plasma (PDP). Finally, the PRP was adjusted to 200,000 platelets/μL with PDP. The antiplatelet activity in vitro assay was done by measured using a lumi-aggregometer (Chrono-Log). Briefly, 480 μL of PRP (200000 platelets/μL) in the reaction vessel were pre-incubated with 20 μL of sample, negative control (saline 0.9%), or positive control (prostaglandin E1 [PGE1]). After 3 min of incubation, platelet aggregation was initiated by addition of 20 μL of agonist, which was measured for 6 min. ADP 8 mM (adenosine 50-diphosphate sodium salt) was used as an agonist.

The average inhibition of the aqueous extracts of fresh tomato (skin + fresh tomato pulp) was 39.5%– 6.9% (early hybrid), 28.5%– 6.4% (intermediate), and 31% – 8.6% (late). Evidence of platelet aggregation was found when using aqueous extracts of tomato paste, since lag time, slope, maximum platelet aggregation, and the area under the curve were significantly lower than the negative control (P<.0001), thus inhibiting platelet aggregation maximum of 30% – 7.1% on average. Extracts of pomace from two growing seasons (middle and late) were compared with negative control values, showing a significantly lower slope, maximum platelet aggregation, and area under the curve (P < .0001), however lag time was not significantly different. Average inhibition of platelet aggregation was 45% – 2% (middle cultivars) and 53% –1% (late hybrids). The maximum platelet aggregation of pomace extracts with high and low proportion of seeds were 29% – 4.6% and 53% – 5%, respectively. Pomace showed higher inhibitory activity of maximum platelet aggregation (51% –16%) than different fresh tomato hybrids (33% – 9.1%) and pasta (29% – 7.1%).

<table>
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<th>K3</th>
<th>THE CHALLENGE OF NUTRITION MANAGEMENT OF PROCESSING TOMATOES IN AN ERA OF RISING YIELD EXPECTATIONS</th>
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</table>
| Oral | Timothy K. Hartz*  
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Worldwide demand for processed tomato products is likely to expand substantially in the next 10-20 years, while constraints on field production will demand greater management efficiency. In California, which produces approximately one third of the world crop, fruit yields have increased 38% from 2000-2015; mean California yields averaged 110 Mg ha-1 in 2015, with individual fields often exceeding 140 Mg ha-1. While the adoption of drip irrigation (which was responsible for much of that productivity increase) is now nearly complete, continued genetic improvement and the application of new technologies will undoubtedly drive tomato yield potential even higher. Unfortunately, tomato producers will increasingly face resource limitations and environmental regulations. In California over this time period irrigation water availability declined and its cost increased, while new government regulations to limit nutrient pollution were imposed. In light of these developments, nutrient management practices in California processing tomato production have been extensively studied in recent years, with the goal of maximizing both nutrient and water use efficiency. The following summarizes that research.

Fruit N content in high-yield fields averages approximately 1.3 kg Mg-1, with marketable fruit typically constituting between 55-65% of total crop biomass N content. This suggests that a total crop N uptake of approximately 2.2 kg Mg-1 of marketable yield should be adequate for maximum productivity, regardless of yield level. Crop N uptake routinely exceeds the seasonal N fertilization rate by 20% or more, and consideration of residual soil NO3-N (which in this semi-arid environment can vary among commercial tomato fields by more than 200 kg N ha-1) is critical to the formulation of efficient, field-specific N fertilization programs. Consideration of rotational management is also important in limiting N leaching losses in tomato production systems.
Fruit P content averages 0.2-0.3 kg Mg⁻¹, with P in marketable fruit representing approximately 70% of total crop P uptake. Currently, P fertilization rates are roughly in balance with total crop P uptake. In fields with bicarbonate-extractable soil P > 15 mg kg⁻¹ P fertilization at a rate to replace P removal in harvested fruit appears adequate to maximize productivity, while in fields of more limited soil P availability greater P fertilization is justified. In organic production the reliance on manure input to supply N often elevates soil P availability to an environmentally problematic level.

By simultaneously restricting rooting volume while increasing yield potential, drip irrigation complicates potassium management. Given the cost of K fertilizer, California growers have been reluctant to fully replace the K removed in harvested fruit (typically 2-2.5 kg Mg⁻¹, representing approximately 70% of total crop K uptake). Current K fertilization rates, which seldom exceed 100 kg ha⁻¹ in California, deplete soil K reserves; yield-limiting K deficiency now occurs with some frequency. Drip-irrigated fields with < 0.5 cmol kg⁻¹ exchangeable soil K are likely to be responsive to K fertilization. Maximizing fruit color uniformity (important in peeling/dicing applications) requires a higher level of soil K availability than does maximizing fruit yield. However, K fertilization solely to improve fruit color uniformity is unlikely to be economically justified; it is more practical to use soil K analysis to select the most appropriate fields for production of fruit for peeling/dicing uses.

Tissue analysis appears to be of limited utility in guiding nutrient management. Whole leaf total macronutrient concentration provides accurate assessment of current crop nutrient status, but leaf N and K do not correlate well with the soil availability of those nutrients until the latter portion of the growing season; early-season decisions on N and K fertilization are best formulated based on soil diagnostics. Petiole NO₃-N analysis appears to be a flawed tool for evaluating crop N status of the strongly determinate processing tomato cultivars currently in use, and adherence to existing petiole NO₃-N sufficiency guidelines will often overestimate N fertilization requirements.

### Table: Evaluation of Different Fertilizer Programmes and Measures of Nitrogen Plant Status for the Guidance of Plant Nitrogen Fertilization in a Processing Tomato on Commercial Farms

<table>
<thead>
<tr>
<th>S3-1</th>
<th>EVALUATION OF DIFFERENT FERTILISER PROGRAMMES AND MEASURES OF NITROGEN PLANT STATUS FOR THE GUIDANCE OF PLANT NITROGEN FERTILIZATION IN A PROCESSING TOMATO ON COMMERCIAL FARMS</th>
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</thead>
</table>
| Oral | V. Gonzalez1, L. Vaquerizo2, JA Gonzalez1, L. Martinez3, MH. Prieto1, C. Campillo1  
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Processing tomato is very important crop in Extremadura, with a surface average of 25000 ha. New trends in this crop and the new technologies are permitting a best management of larger plots with high soil heterogeneities.

This situation requires the technician needs to take a decision in the fertilization management that it can affect differently in areas of the farm, causing differences in production and crop quality.

To establish an optimal fertilization is important to maintain the balance of vegetative and reproductive plant to obtain fruit with high organoleptic and nutritional quality. In this situation, the “theoric” fertilization scheduling can produce heterogeneity in production and loss the profitability of crop. In this sense to establish methodologies and sensors that can help manage the nutritional levels of the crop quickly, can help establish a more adjusted needs of the plant fertilization in each area and during all crop cycle with the aim of more efficient crop production. The use of new technologies for plant nutritional status detection, it is a breakthrough for fertilizer plan predictions and corrections.
The aim of this study was to determine the influence of different doses of nitrogen fertilization on yield and quality parameters in processing tomato crop in Vegas del Guadiana and to evaluate different crop nitrogen status sensors to detect nitrogen deficit. The project was carried out in a commercial plot of processing tomato of ROMA SL Company, with H2401 tomato variety of medium cycle (125-135 days).

The experimental trial design consists of a total area of 4050 m² in 30 crop lines. The elemental plot was 405 m², with four replicates for each treatment. The irrigation system was performed using drip irrigation buried 15 cm deep and fertilization through an initial, before transplanting of 40 kg/ha of mineral nitrogen applied at all trial surface and the rest of nitrogen (200 Kg/ha) by fertigation during the all crop cycle.

Five treatments were raised according to the time and amount of mineral nitrogen fertilizer applied during the crop cycle: T1: without fertilization after transplanting; T2: fertilization after transplanting depending on the parameters measured in the culture; T3: fertilization after transplanting in first part of crop cycle (transplanting to fruit set) and without fertilization in second part of the cycle (fruit set to harvest); T4: without fertilization in firs part of the cycle and fertilization after transplanting in second part of crop cycle (fruit set to harvest); T5: fertilization after transplanting use for the farmer common in the area (220 Kg/ha).

Different parameters (canopy cover, Biomass, flowering and fruit set) were studied during vegetative crop development and yield at harvest in order to analyse the differences between the different treatments. In T2 treatment different nitrogen status indicators (canopy cover, chlorophyll, nitrate content in sap, leaf nitrogen concentration and reflectance) were used to analyse the plant nutritional status in different parts of the crop cycle.

The measurements were performed every 15 days. The indicators used were able to differentiate between extreme treatments. The rest of the fertilization elements (P (160 Kg/ha) and K (300 Kg/ha)) were applied in all treatments.

The evolution of canopy cover was a good method to observe the evolution of the canopy cover at different stages of growth between treatments. Sap analysis showed significant differences between treatments in the vegetative phase and the beginning of flowering. The reflectance sensor allowed detecting heterogeneities in the different blocks and identifying the most representative points for measures.

No significant differences in production and quality between the different treatments were found. The results showed that in all treatments and in all phases of plant development there was an excess nitrogen fertilization, without this positively influenced in the final yield.

This work has been permitted to evaluate different indicators to analyse the nitrogen status in the plant, with the aims of to dispose rapid methods of deficit nutrition status to permit to do corrections from first phase of crop cycle with different sensors and to detect over-fertilization for an efficient use of nitrogen in commercial farms.
Managing nitrogen fertiliser and irrigation to reduce nitrous oxides emissions is a win for the environment, your health and farm productivity

Introduction
Nitrogen fertiliser and irrigation management not only drive processing tomato yields but also play a major role in determining the environmental credentials of the resulting tomato products. A consequence of using nitrogen fertilisers is the potential risk of producing nitrous oxide emissions. These nitrous oxide emissions are a potent greenhouse gas, increase ultraviolet radiation and skin cancer by depleting the ozone layer, and waste applied nitrogen fertilisers. Managing nitrogen fertiliser and irrigation to reduce nitrous oxides is a win for the environment, your health and farm productivity. The use of sub-surface drip irrigation combined with nitrogen fertigation can substantially reduce nitrous oxide emissions as shown by studies in California. This study monitored nitrous oxide emissions across four sites on commercial farms growing processing tomatoes in Victoria to establish data for Australian conditions.

Materials and Methods
Four sites in the Rochester-Echuca-Boort area of Victoria were monitored during the 2014-15 growing season. Cultivation was similar across the four sites and involved disc, power harrow and deep ripping prior to bed forming. Basal fertilisers were applied during these cultivation events. All sites applied metham sodium (192 L ha⁻¹) 15-27 days before planting. Irrigation was applied using only sub-surface drip, with a single drip line buried 25cm along the middle of the bed.

Static chambers were used to measure nitrous oxide emissions from the four sites. At each site eight chambers (diameter 243 mm; height 205mm; installed volume of 7.3L) were installed, four on the shoulder of the bed and four in the centre of the bed directly above the sub-surface drip line. Chambers were located across four beds and were left in the ground between sampling unless cultivation events required their removal. The project used the Cool Farm Tool and the Intergovernmental Panel on Climate Change. Default emission factor to estimate nitrous oxide emissions. Based on these estimates, crop emissions on an area basis (kg N₂O-N ha⁻¹) and as emission intensity (g N₂O-N tonne fruit⁻¹) were calculated. The crops were mechanically harvested and yield (tonnes ha⁻¹) measured at each of the four sites on the 5/3/2015, 12/2/2015, 11/2/2015, and 11/3/2015, respectively.

Results and Discussion
Across sites 2, 3 and 4 little variation in overall crop nitrous oxide emissions was observed with values ranging from 0.18 to 0.24 kg N₂O-N ha⁻¹. However, site 1 produced crop nitrous oxide emissions seven times higher than the other sites. The high crop nitrous oxide emission from site 1 was largely due to high daily emissions immediately following planting. At site 1 nitrous oxide emissions jumped from background readings, averaging 0.95 g N₂O-N ha⁻¹ day⁻¹ in the lead up to planting, to a peak of 78 g N₂O-N ha⁻¹ day⁻¹ six days after planting. No such spikes in emissions were seen at the other sites.

The emission intensity varied more than crop nitrous oxide emission due to these yield variations. Site 4 produced the least emission per tonne of fruit with an emission intensity of 1.08 g N₂O-N tonne fruit⁻¹. The emission intensity doubled to 2.14 and 2.18 g N₂O-N tonne fruit⁻¹ for sites 2 and 3, respectively. But site 1 had the largest emission intensity with a value of 10.86 g N₂O-N tonne fruit⁻¹.
The modelled nitrous oxide emission values were considerably higher than the measured values for both the Cool Farm Tool and IPCC methods. On average the models overestimated crop emission by 10-12 times, compared to that measured during 2014-15, for sites 2-4. For site 1 the over estimation was only 0.8 times. Neither the Cool Farm Tool nor IPCC produced the variation in emissions across sites that was observed in the measured emissions. For example, the Cool Farm Tool’s estimated emissions varied by 75% between the highest and lowest site, while the measured emissions varied by 830%.

Planting time was identified as the greatest risk period for nitrous oxide emissions from processing tomatoes. Over the whole cropping season sub-surface drip irrigation improves water and nitrogen management, reducing the risk of nitrous oxide emissions. However, total reliance on sub-surface drip for irrigation makes watering up at crop establishment difficult. To wet up the surface soils at planting requires excess water to be applied to allow water to wick up from the sub-surface drippers. This results in saturated soils creating conditions conducive to nitrous oxide emissions when soil nitrate-nitrogen is available. At site 1 large nitrous oxide emissions were measured when the soil was saturated immediately following planting.

<table>
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<tr>
<th>S3-3</th>
<th>EVALUATING WATER STATUS IN PROCESSING TOMATO USING COMBINED INFORMATION FROM DIFFERENT SENSORS</th>
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<tr>
<td>Oral</td>
<td>C. Campillo1, S. Millan1, R. Fortes1, I. Laho2, M.H. Prieto1 and J.I. Macua2*</td>
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The lack of water and the current rules into water use have generated new strategies to improve water use efficiency. This situation requires new agricultural techniques aimed to reach a better control into the water use on the agricultural management and especially in the management of large areas of crop. In this situation the sensors to measure crop water status can be used to more efficiently water irrigation management and get higher yields and with better quality with lower amount of water.

The objective of this work is to evaluate different sensors (continuous and discontinuous) to measure the water status to establish recommendations for efficient crop management for water saving in the last stages of cultivation and its effect on different processing tomato varieties. This work was development in 2014 in Extremadura. Four processing tomato cultivars (H9997, H9661, ISI 24424 and H9036) were studied. The statistical design was a split plot with four replications where the main factor was the irrigation rate (25%, 50% and 100% ETC) and the second factor was variety. Deficit irrigation (25 (RDC25) and 50% ETC (RDC50) only was applied from fruit development to harvest, in the rest of the crop stages were applied all water requirements (100% ETC (Control)). Different commercial sensors were studied, to evaluate crop water status weekly: (1) Discontinuous sensors; leaf water potential (Pump-Up Pressure Chamber, PMS instruments), soil water content (Watermark, Irrometer) and ground cover (digital camera, canon) (2) continuous sensors; canopy infrared temperature (Apogee Instruments) and reflectance (Crop Circle ACS-470, Holland Scientific, Inc). The infrared temperature and reflectance measure were measure in all surface of the experimental plot by hand. Measurements are recorded on cr1000 logger (Campbell Sci) with GPS every second. The first measures with continuous/mobile sensors were used to locate the measure zone to discontinuous sensors. Leaf water potential, infrared temperature and soil water content sensor allowed detected deficit irrigation in the last phase of the crop cycle. However leaf water potential and infrared temperature detected water deficiency faster than soil water content sensor. The soil water sensor allowed knowing the water variation between treatments, but with high variation between blocks. These sensors have demonstrated to be good methodologies to manage the risk of water stress in this last phase. The reflectance sensor and digital camera indicate a variation of canopy cover, but this variation...
was shown later than the other sensors. The reflectance sensor allowed detecting heterogeneities in the different blocks and identifying the most representative points for measures in the moment to initiate the water treatments. The different stress levels were showed in commercial production. The treatment with severe stress (RDC25) had a loss of commercial production from the rest of the treatments, the treatment with medium stress (RDC50) showed no significant loss of production. The results obtained will permit to establish the measuring ranges on correct water status and water stress with different types of sensors for water management in processing tomato and to know what is the best sensor to detect water stress. This information will allow to the farm technicians to control the deficit irrigation strategies with improved quality and without significant loss of production.

**S3-4 DEVELOPMENT OF AN EFFICIENT WATER MANAGEMENT SYSTEM IN PROCESSING TOMATO COMMERCIAL FARMS**

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<tr>
<td>C. Campillo1*, J. Gordillo2, LM. Santiago2, A. Cordoba2, L. Martinez3, MH.Prieto1 and R. Fortes1.</td>
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<td>* Corresponding author: <a href="mailto:carlos.campillo@gobex.es">carlos.campillo@gobex.es</a></td>
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The current rules of rational water use and widespread shortages have created a strong need to create aimed at improving the efficiency of its use strategies. New trends in processing tomato and the new technologies are permitting a best management of larger plots with high soil heterogeneities. This situation requires the technician needs to take a irrigation decision that it can affect differently to the different areas of the crop, causing differences in production and crop quality. The estimation of the water needs of crops is usually performed by water balance in the soil or by methods of calculating potential evapotranspiration, this methodology is influenced by climatic parameters, development of crop and soil texture. New technologies applied to irrigation management, such as precision agriculture, can help make a schedules tailored to the real needs of each crop. The objective of this project is to establish a management system of a commercial plot, to facilitate better management of the water needs of processing tomato crop and develop a model to adjusting irrigation schedules adapted to the different characteristics of different irrigation sectors, from direct measure in the field. For this study, a project was conducted two years in commercial plots belonging to the ROMA Company. For efficient management of irrigation water an irrigation model based on the FAO 56 recommendation paper and adjusted to local conditions and water status was developed. The agroclimatic conditions, obtained of the near agrometeorological station and measure of percent of ground cover were used to the adjusted of phenological phases and crop coefficients. On the control zones, leaf water potential and percent of ground cover were measured. These water status values allowed corrections and adjustment on irrigation schedules with different threshold in function of the crop phenological status.

This system has allowed to adjust the amount of water applied in different areas of irrigated plots and establish automatic corrections in real time. The accumulated degree days and canopy development permitted to adjust the irrigation needs and the crop coefficients over theory calculations. Water potential measurements were used to increase irrigation recommendations in 10% in the case the value were below established limits. The adjust model permitted savings of up to 20% water in commercial fields and avoid situations of water stress or over-irrigation in different phenological stages of the crop. The model permitted to establish different deficit irrigation strategies too. The innovative content of the new model tested was to use a different plant measures (canopy cover and leaf water potential) to adjust the water requirements of different phases of processing tomato (crop coefficients) estimated for each of the different plots of the farm and/or crops with special situations, to permit to technicians an efficient water management in processing tomato commercial farms adjusted to the local situations.
Many studies have demonstrated that the yield quantity and ingredient content is significantly determined by the genetic nature of varieties, but this does not exclude the fact that abiotic (water supply, etc.) and biotic (mycorrhizae, etc.) factors also strongly affect it. A two year (2013 and 2014) open field experiment was conducted to study the effect of mycorrhizae and different water supply on the yield parameters and carotenoid concentration and composition of processing tomato. Fruits were harvested from green to red maturity stage during two consecutive years.

The experimental field is brown forest soil, with mechanical composition are sand, sandy-clay and the subsoil water is below 5m, therefore it cannot influence the water turnover. Seeds were sown on the 5th of April in 2013 and 2th of April in 2014 in greenhouse and transplanted on the 9th of May in 2013 and 11th of May in 2014. The experimental design was randomized block, number of replications were four for each treatments. Seedlings were arranged in double (twin) rows with a distance of 1.2 and 0.4 m between the rows and of 0.3 m between the plants. After transplantation, half of the seedlings were inoculated with Symbivit®.

We tested two varieties Uno Rosso and Strombolino. There were six different treatments: control (rainfed) and control + mycorrhized, deficit water supply (50%), deficit water supply + mycorrhized, optimum water supply and optimum water supply + mycorrhized. Drip irrigated water was given out according to the air temperature (daily irrigation water (mm) = average daily temperature×0.2). National Meteorological Institute forecasts were used to calculate with the probable air temperature. Red and green fruits were measured at harvesting on the 21th of August in 2013 and 17th of August in 2014. The analytical analysis was made in the Regional Knowledge Centre, using HPLC (High Performance Liquid Chromatography) following the method of Daood et al. (2013).

The two-years experimental were fundamentally different for temperature and precipitation. Accumulated precipitation was 166.2 mm during the growing season in 2013, July and the first half of August was practically rainless. In contrast, accumulated precipitation was more than twice (380.7 mm) during the vegetation period in 2014. Two months before the harvest, precipitation was 270 mm, but there was no precipitation during the fruit set period. It was more hot days in 2013 (the maximum temperature was above 35 °C for several days), while cool weather was in 2014 (the maximum temperature was between 20 to 25 °C), during the period of ripening. This was expressed in the yield quantity and quality (for example, the lycopene content).

In case of Uno Rosso variety, yield quantity varied between 26.3 and 113 t/ha, depending on the treatment. We could not detect any significant difference in mycorrhized treatments, due to the high standard deviation in 2013. In contrast, the yield quantity was significantly increased by the mycorrhized irrigated treatments in case of Uno Rosso F1. On the other hand, it is very important to mention that the mycorrhization caused no significant difference in the yield quantity in unirrigated treatments.

We have received a significantly higher concentration of carotenoids in the second experimental year.
A fully replicated trial was set up comparing 3 treatments, Control 0 l/ha, 75 l/ha of GYP-FLO injected in irrigation lines, and 150 l/ha of GYP-FLO injected in irrigation lines (in two applications of 75 l/ha).

GYP-FLO was a form of liquid gypsum. However, gypsum (calcium sulphate) is not the primary ingredient of this product as GYP-FLO is made from finely ground calcium carbonate (lime) and elemental sulphur (S). The label states that the product has the equivalent of approximately 35% w/v of calcium and 25% w/v sulphur respectively. The sulphur content of GYP-FLO, which we had measured using acid digestion at two commercial laboratories, indicated only 5 – 6 % w/v S. However, further testing using Elemental Analysers, proved 13 – 20% w/v S in a range of GYP-FLO batches. This highlights a problem with commercial laboratory tests for products containing elemental sulphur, either due to gaseous loss in digest preparation or in measurement of the S.

Although aggregate wet sieving results did not show significant differences between GYP-FLO treatments, the Emerson test (test for physio-chemical clay dispersion) indicated that the samples after GYP-FLO treatment were more resistant to dispersion than the samples from the control treatments. This can be explained by the substitution and leaching of the exchangeable magnesium and sodium by calcium from the fine lime supplied in the GYP-FLO. Also the ESP (exchange sodium percentage) was lower in samples in the GYP-FLO treated soil and there was also a higher Ca:Mg Ratio, both positive outcomes for soil structural stability.

Differences in soil properties were also investigated under long-term Subsurface Drip Irrigation (SDI) used for processing tomato production in northern Victoria, Australia. The samples were collected from the same depths of 0-10, 10-20 and 20-30 cm but different horizontal locations along the dripper tape and distances from the emitter. These locations were under the emitter, 22.5 cm and 45 cm towards bed edge from emitter, between emitters (25 cm from emitters) and a diagonally extreme point which was the farthest point from emitter.

Water Stable Aggregate (WSA), Electrical Conductivity (EC), Soil pH, Exchangeable Cations (Ca, Mg, K and Na), Exchangeable Sodium Percentage (ESP), Ca:Mg ratio and CEC were measured. The results of most of the tested properties showed positive (increasing) relationship with distance away from emitter, excluding potassium and the negative trend for Ca:Mg ratio. At all locations effects were only statistically significant for EC (P<0.01), soil pH (P<0.01), exchangeable sodium (P<0.01) and ESP (P<0.05). These results indicated that cations were possibly washed away from the emitter during 4 years of SDI.

The decreasing ratio of exchangeable calcium to exchangeable magnesium (Ca:Mg) with increasing distance away the emitter may relate to calcium supplied via the fertigation system. The exchangeable sodium increased to more than double that of under emitter toward the extreme point suggests either leaching of sodium or general loss of CEC due to clay migration. The extent of the increment was higher in the direction towards the edge of the bed than along the row.

Particle Size Distribution (PSD) of samples from under emitter and between emitters was also compared. The PSD result indicated that samples from between emitters were higher in the proportion of ‘fines’, i.e. particles <100 µm, but
lower in coarser fraction, especially sizes ranging between 650 – 1500 µm (coarse sands). This suggested that very fine sand, silt and clay might be migrating away from under the emitters with irrigation to more distal areas of the bed. These findings indicate real chemical and physical changes can occur to soils under longer term subsurface drip irrigation and suggest general leaching and migration of finer particles with irrigation.

### Table S3-7

<table>
<thead>
<tr>
<th><strong>SEASONAL AND IRRIGATION EFFECT ON YIELD PARAMETERS AND SOLUBLE SOLIDS CONTENT OF PROCESSING CHERRY TOMATO</strong></th>
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<tbody>
<tr>
<td><strong>Oral</strong></td>
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<tr>
<td>Zoltán Pék*, Péter Szuvandzsiev, András Neményi and Lajos Helyes</td>
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<td>* Corresponding author: <a href="mailto:Pek.Zoltan@mkk.szie.hu">Pek.Zoltan@mkk.szie.hu</a></td>
</tr>
</tbody>
</table>

Tomato is cultivated all over the world and is one of the most consumed vegetables in recent days. It is a significant food crop with 164 million tons harvested in the world in 2013 (FAO, 2015) and characterized by high consumption, year-round availability, and significant health benefits. Cherry tomato is an ancient type of fresh market tomato grown in the world, especially in Italy. Processing cherry tomatoes, which are unique and new for the processing tomato industry, with determinate growth habit and increased soluble solids content, are a new perspective in improving processed tomato product quality, which might be suitable to improve the quality of tomato-based food products.

The objectives of this study were to evaluate the influence of irrigation and seasonal variations on the yield components of processing cherry tomato Strombolino F1.

During five years (2010-2014) open field experiments were conducted to study the effect of different water supply on the yield components (yield, fruit number per hectare, average fruit weight and Brix) of Strombolino F1, cherry type processing tomato on the Experimental Farm of the Institute of Horticulture, Szent István University, in Gödöllő, Hungary.

The experimental field is on brown forest soil, with mechanical composition of sand and the subsoil water is below 5m. Seeds were sown in the first week of April in heated greenhouse and transplanted after last spring frost in the beginning of May in all years. The experimental design was randomized block, with four replications for each treatment. Tomato plants were arranged in twin rows with a distance of 1.2 and 0.4 m between the rows and 0.3 m between the plants. Crop density was 4.2 plants m-2. Basic nutrition supply was given out when plants were transplanted.

Regularly irrigated (STI) crops were compared with rainfed control (STC). Regularly irrigated plants were irrigated with the calculated amount of water from the beginning of June to the end of July. The water supplies of crops were 500, 489, 596, 344, 521 mm in STI, and 351, 153, 219, 163, 353 mm in STC treatments respectively, during the five seasons. Irrigation water was given by drip irrigation equipment, one lateral for every twin rows. The spacing between the emitters was 0.3 m, and the discharge rate of the emitters was 4 Lh−1. The experimental design was randomized block, with four replications for each treatment. Meteorological data were recorded six times per hour by a Campbell CR21X datalogger.

There were single harvest dates in all years, by manual evaluation of fruit yield and parameters (number of fruits, fruit weight and soluble solids content). The Red ripened, green and non-marketable fruits were measured at harvesting in four repetitions in August. Brix was examined with refractometer (AST 1230, Tokyo, Japan). All statistical analyses were made in IBM SPSS 22.
The seasonal effect of the five years was significant, because during the last 100 years the rainiest season was in 2010, and the droughtiest season in 2011. Irrigation had a greater effect on the average fruit weight ($R^2=0.57$) than on fruit number ($R^2=0.0003$) because of the limited number of flowers in the determinate growth habit of processing tomatoes. Seasonal variations on yield affect mainly by the harvestable fruit number, and it is influenced significantly by weather during the flowering period. The irrigated plants gave a significantly higher marketable yield, compared to rainfed plants. We observed positive correlation between the water supply and total marketable yield. Increasing water supply increases fruit yield but significantly reduces Brix (dilution effect), nevertheless the overall effect of irrigation was the increase in total Brix yield, because of the high correlation ($R^2=0.82$) between yield and Brix yield.

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### CHARACTERIZATION OF THE WATER NEEDS OF TOMATO FOR PROCESSING IN EXTREMADURA (SPAIN)

<table>
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<tr>
<th>Oral</th>
<th>L.L. Paniagua1, A García-Martin1, M.A Rozas1, E. Ordiales Rey2 and J.L. Llerena2,3</th>
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The processing tomato crop is the main food crop in Extremadura, with an irrigated surface area of 21,674 ha in the 2014 season, and a yield of over 1.4 million tons (74.92% of Spanish national production). The primary growing areas are in Las Vegas along the Guadiana River stretching some 150 km from the regions of La Serena and La Siberia to the capital of Badajoz where the river forms a natural border with Portugal. It is an extremely important agricultural area which has been transformed from a dryland farming zone by means of a national irrigation program.

Water is a defining factor for the world economy due to its dwindling availability and declining quality, combined with the challenge in ensuring its secure and consistent distribution. Rainfall estimates and water distribution programs particularly in the world’s driest areas remain uncertain, but an inter-governmental panel of experts on climate change warn that the areas that will be the hardest hit by climate stress will be semi-arid areas such as Spain.

The classification of growing areas, according to water requirements, based on different crop cycles, allows us to predict requirements and adapt our choice of plant varieties. Zoning studies not only serve to determine the production potential, but also to analyse variability and provide the basis for sustainable management.

Three distinct cycles can be identified as representative of cultivation in Extremadura: transplantation which begins on the 20th of April (20A) and lasts for 110 days (long cycle), transplanting on the 15th of May (15M) and the 1st of June (1J) with a duration of 90 days each respectively (short cycles). All three cycles were analyzed to ascertain the optimum amount of water required: during the vegetable growth stage (CV), the setting of the fruit (DF) and fruit ripening (MF).

Data from weather stations belonging to the Irrigation observation network of the regional council estimate water needs for growing different tomato varieties for short medium and long term-cycles as 110; 140 and 160 days respectively. From this data a principal components analysis (PCA) was performed to limit discrepancies among the variables studied. Furthermore, to obtain a climate grouping based on specific criteria a ranking system was introduced. Once the number of clusters was defined, a non-hierarchical classification was performed to group stations into subgroups. The results highlight the variety of differing irrigation necessities that exist in cultivated areas and identify homogeneity in the area in general.
Powdery mildew caused by Oidiopsis sicula is the most damaging common foliar pathogen in processing tomatoes in California’s Central San Joaquin Valley. The initial symptoms of this disease include light green to yellow angular lesions. Sporulation may be visible on the lower and upper leaf surfaces. Small lesions become necrotic at later stages of disease development and expand to cause leaf death with leaves remaining attached to the stems. When disease is severe at early stages of crop development, substantial crop loss can result.

In this production area, repeated fungicide applications are required to prevent this pathogen from causing economic damage. In field experiments conducted at the University of California West Side Research and Extension Center, materials for control of this pathogen were evaluated from 2009 to 2015. Processing tomato cv. Sun 6366 transplants were mechanically planted in mid-May. Drip irrigation tubing was buried to a depth of 25 cm and used throughout the trial. Other than fungicide applications, all practices to grow the crop were approximated at this trial site. Twelve to 17 treatments and an untreated control were compared annually in a 4-replication randomized complete block design. Plot size was a single 1.5-meter bed, 15 meters in length. Disease severity was evaluated based on a scale of 0 to 100, with 0 being apparently unaffected and 100 being completely covered with symptoms or signs of powdery mildew. Environmental conditions during the July and August periods, while disease was developing, was consistently hot (daily high temperatures exceeded 30°C) and dry with no reportable rainfall. The levels of powdery mildew were high to very high in untreated controls during 5 of 7 seasons.

During all years, there were sufficient levels of disease to see treatment differences. Fungicides that consistently demonstrated good to excellent levels of control in these studies include quinoxyfen, cyflufenamid, tetraconazole, pentaconazole, trifloxystrobin formulated with difenoconazole, pyraclostrobin formulated with fluxapyroxad, and trifloxystrobin formulated with fluopyram. In addition, frequent applications of dusting sulfur beginning before symptoms or signs of the disease are present, will also provide excellent levels of control under the environmental conditions present in Central California.
from Solanaceae hosts were found in the families Apocynaceae, Campanulaceae, Crassulaceae, Cistaceae, Linaceae, Malvaceae, Papaveraceae, Pedaliaceae, Scrophulariaceae, Valerianaceae and Violaceae.

Nonhost resistance within these families is not based on inhibition of formation of primary haustorium, however on post-haustorial hypersensitive response (HR) and another type of non-hypersensitive resistance. Screening of wild Solanum sect. Lycopersicon species (previous Lycopersicon spp.) germplasm revealed valuable sources of resistance (S. habrochaites, S. pennellii, S. cheesmaniae, S. chilense, S. peruvianum). The main resistance mechanism was found to be a HR, in some cases followed by limited development of the pathogen.

However, there is a broad variation in resistance response on the histological and cytological level. Interaction between many wild Solanum spp. and O. neolycopersici is race-specific; at least three races were differentiated. In some interspecific crosses (S. lycopersicum × S. habrochaites) adult plant resistance was observed. Biochemical studies focusing on production of reactive oxygen species (ROS) and peroxidase activity during infection of O. neolycopersici showed that production of ROS and activity of corresponding enzymes are related to activation of defense responses in genotypes of wild Solanum sect. Lycopersicon. The significance of nitric oxide (NO) in O. neolycopersici pathogenesis was supported by experiments with NO donors and scavengers. In moderately resistant genotype S. chmielewskii, treatment by heat stress caused slight deceleration of pathogen development, increased production of jasmonic acid (JA) and abscisic acid (ABA) and increased peroxidase activity in infected plants. The different degree of tomato resistance/susceptibility did not markedly change the rate and extent of photosynthetic response to O. neolycopersici; only minimal impairment of photosynthesis was found in both susceptible and moderately resistant genotypes during the first 9 days after inoculation.

The accumulated evidence confirms a crucial role of localised increased production of ROS and reactive nitrogen species (RNS) in response to pathogen penetration into plant tissue and its involvement in the plant resistance responses including the initiation and progression of plant cell death in host wild Solanum species. Crucial points of further research are discussed.

**S4-3 THrips Management in Processing Tomatoes and Influence on Tomato Spotted Wilt Virus Symptom Incidence in Central California**

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Tomato spotted wilt virus (TSWV) can inflict substantial economic damage in the Central California production area where processing tomatoes are the most valuable vegetable crop grown. Between 2002 and 2005, this disease increased from negligible incidence to affecting the majority of the plants in some fields and causing substantial economic damage.

The primary vector of this disease in Central California tomatoes is Western flower thrips, Frankliniella occidentalis, which can maintain very high population densities from May through the middle of October. Growers in this production area had little understanding of this virus or vector at the onset of the increased damage. As a component of a comprehensive research project on the disease, insecticide program evaluations were conducted.
To address questions regarding the utility of insecticide programs in managing this disease, efficacy of insecticides against thrips were compared in trials conducted from 2007 to 2012 and insecticide programs were evaluated in trials conducted from 2009 to 2012. In all studies, processing tomato cv. H8004 were transplanted onto 1.5 meter beds and irrigated with 25 cm deep to drip irrigation tape. In the insecticide efficacy experiments, 7 to 12 materials were compared annually.

The experimental design was a 4-replication randomized complete block. Thrips population densities were quantified by nymph and adult counts per 25 flower samples that were collected 3 to 5 days after the last application. In the insecticide program comparisons, the experimental design was a split plot with 4 replications: Main plot treatments were drip applied materials consisting of the following: a) Thiamethoxam 3-4 weeks after planting, b) Thiamethoxam 3-4 weeks after planting with a subsequent application of dinotefuron 3-4 weeks later, and c) an untreated control. Sub-plot treatments were rotations of foliar applied insecticides, which were spinetoram and dimethoate rotations applied 2 or 5 times at 10 day intervals. Also, during three of the seasons, cyantraniliprole was applied as a transplant drench 24 hours before planting. The thrips population densities were quantified as in the efficacy studies. Also, the number of TSWV-symptomatic plants were quantified per plot 2 to 3 times during the season and the percentage of TSWV-symptomatic plants were calculated based on the number of total plants per 75 ft plot. Plots were mechanically harvested and a 12 kg sub-sample was hand sorted into red, green, sunburn, rot and TSWV categories and percentages were calculated. A sample of red fruit per plot were tested for solids, pH and color.

Thrips population densities were high in all trials and TSWV incidence was high to very high. In the efficacy trials, very few materials consistently were associated with a significant reduction in thrips population densities. The only materials that consistently provided quantifiable levels of control were limited to spinetoram, mehomyl and dimethoate. Reductions of TSWV incidence were documented in 2009, 2011 and 2012 due to foliar programs and in the cyantraniliprole treated plots in 2011 and 2012. No differences between the treatments with neonicotinoid injections and untreated were observed. In 2010, TSWV incidences in commercial fields nearby were very high and no differences among treatments were observed possibly due to inundation by TSWV-infected thrips from external sources. Insecticides tested in these studies will not deliver commercially acceptable levels of control when very high population densities of TSWV-infected F. occidentalis are moving into the field. This is especially true if plants are at early stages of development at the time the high population are present. However, prudently timed, effective insecticides can reduce the potential disease incidence or delay onset, thereby reducing the level of damage.

When used with other disease management tactics, insecticide applications may be able to keep damage below economically important levels.
The decisions are related to the sizing of cultivated tomato areas, transporting tomatoes from growing fields to the processing plants, industrial processes to produce concentrated raw-materials (concentrated tomato pulp) and final products to consumers, as well as managing inventories and transportation of this tomato pulp to and from the plants in the system. There are several tomato varieties available by seed companies, having distinguished agronomic features (yield, disease and weed resistance, maturity curve etc.) and also industrial ones (soluble solids content, pulp color, fruit firmness etc.).

All these features make decisions concerning agriculture and industry difficult to be analyzed and to be taken, especially regarding the choice of the tomato variety for producing regions, as well as planning plantation and harvest schedules to meet industrial requirements. In the processing industry, analyzing strategic and tactical decisions related to the production of concentrated tomato pastes and final products is particularly challenging due to the uncertainties in the supply of tomato and product demand of the markets. In practice, the companies of this industry plan the tomato planting and harvesting in producing regions by designing a likely scenario of the tomato season by using electronic spreadsheets. Tomato plants can be seriously damaged by rainfall, and it is not possible to perform farming operations in heavy rainy periods. In good weather conditions, agricultural teams often plant more tomato areas than planned in contrast to few planted areas when the climate is unfavorable.

By planting more in some periods and less in others seriously affects the industry due to an excess or lack of tomatoes at harvesting time. Thus, production and logistics costs increase, either due to physical losses of tomatoes in long unloading queues or to idleness of industrial facilities. The processing tomato season extends for four months a year, whereas the demand of tomato-based products is throughout the year. These features are conflicting between the objectives of the agricultural teams, which aim to maximize the tomato production during the harvest, and the targets of industrial teams, who attempt to adjust their production according to the market demands. These conflicts are partially solved by transforming harvested tomatoes into semi-finished products (concentrated tomato pastes), which are stored and subsequently consumed throughout the year.

These are examples of management issues that the processing tomato industry faces annually in crop and industrial planning, which can be analyzed by using mathematical programming models and optimization tools. The contribution of this study is to present a conceptual scheme of the production and logistics planning problem in the tomato processing industry based in a case study in Brazilian companies and to propose mathematical models, which appropriately represent and optimize key tactical planning decisions.

To the best of our knowledge, we are not aware of other studies in the literature in this line of research.

Material and methods
Techniques from the field of Operations Research, such as linear and integer programming, robust optimization were used in this research. The models were implemented in the General Algebraic Modeling System (GAMS) and solved by the CPLEX optimizer.

Main results
The mathematical programming models developed appropriately represented and optimized the processing tomato agro industrial system. The models were able to support the key tactical planning decisions in the agricultural and industrial activities. Extensive computational experiments were carried out to analyze the solutions obtained compared to the company’s achievements and plans. The models solutions suggested production and logistics plans that led to better economic results compared to the company’s accomplishments and plans, and obviously the economic gains depended on the set of data used. The overall outcomes of this study are promising and encourage further research. This study intends to contribute to developing a decision support tool to plan the activities in the tomato
processing industry. The results obtained were validated by managers and experts from the tomato processing industry, who recommended the proposed optimization approaches showing that they have the potential to help with the planning of tomato crops and industrial processing activities.

### P1-1 RESPONSE OF TOMATO PLANTS TO POTASSIUM FERTILIZATION UNDER GREENHOUSE IN ARID CONDITIONS

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Tomato plants grown in greenhouses require relatively high levels of potassium (K) regimes for optimum growth, yield and fruit quality. Greenhouse managers and farming industry owners who established their projects under the arid conditions of Saudi Arabia are applying K fertilizers to tomato plants without taking into consideration the actual plant requirements of this essential element. Therefore, four levels of K fertilizer (100, 150, 200 and 250 ppm) were applied in fertigation method to tomato plants grown in greenhouses since processing tomatoes are produced in greenhouses in Saudi Arabia; to evaluate their agronomic performance in response to various levels of K fertilizer. Soil K level where the plants were cultivated was only 30 ppm. Results revealed that increasing potassium rates resulted in a significant increase (p>0.05) in leaf K content, chlorophyll concentration, and carbohydrate contents. Tomato fruits produced from plants received high level of K (250 ppm) showed superiority over those produced from plants received low level of K (100 ppm) regarding percentage of total soluble solids contents and firmness which measured by pressure tester. Moreover, there was a direct proportional relationship between the level of applied K fertilizer and studied fruit quality parameters (percentage of total soluble solids, firmness). In addition, our data reported in the present study revealed that under the suggested K regimes investigated, the marketable yield increased linearly with increasing K levels.

### P1-2 PROCESSING TOMATO CULTIVATION IN SOUTH KOREA

| Poster | Choon Gil Kang*, Seung-Chul Yang, Ki Ju Hong, Byoung Sang Chung  
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The amount of processing tomato consumption in South Korea accounts for 36% of all tomato consumption. Most processed tomatoes are imported in the form of concentrate including puree and paste. In Korea, ketchup, pasta sauce and juice are well known as general tomato products, but for cooking products e.g. canned tomato, whole and diced tomatoes are not generally used at home in South Korea. Due to this, the tomato consumption per capita of Korean is less than half of the world average. Processing tomatoes are not grown in Korea, while fresh and cherry tomatoes are produced. One of the reasons for this is that the climate of South Korea is different from other countries which processing tomatoes are usually grown in. For instance, annual temperature difference between summer and winter of Seoul is greater than that of California and Rome. South Korea also has a greater amount of precipitation during summer, the ideal time to grow processing tomatoes. This is the reason tomatoes are not grown in the field in South Korea. Therefore, tomatoes (indeterminate type) are normally cultivated in the greenhouse with guide ropes considering productivity especially in winter season. The purpose of this study is to investigate the possibility of cultivation of processing tomatoes and to develop new processing tomato cultivars which are suited for the environment of South Korea.
Twenty cultivars of processing tomato were grown from March to August in the greenhouse for two years (2013-2014). The experimental group was sorted into 10 determinate types (or bush type) and 10 indeterminate types. The basic information such as maturity, fruit shape, plant vigor, and disease tolerance of each plants were investigated during the cultivation. Characteristics of each cultivars including fruit color, NTSS (natural tomato soluble solid), firmness, productivity were measured to evaluate the relative qualities. Tomato pastes was made via the following steps: washing, crushing, breaking, finishing, evaporating, sterilizing, filling, and cooling. Color, total acidity, viscosity, and serum viscosity were measured at the same brix.

Cultivars of indeterminate type generally showed high score on fruit color, productivity, mean weight, and hardness. Indeterminate cultivars range in weight from 93 to 160 g, while determinate cultivars range in weight from 62 to 125 g. Productivity, which was multiplied by the number of fruit per plant and the mean weight, showed that indeterminate types were higher than determinate types. On the other hand, firmness of determinate types (580-610 g/cm2) was harder than indeterminate types (540-590 g/cm2). In the properties of tomato paste including color and viscosity, determinate type cultivars showed better results rather than indeterminate type. However, there was no significant different in total acidity among cultivars. There was a distinct different among tomato pastes in the a/b value, which is color index of tomato paste. The a/b value of the determinate types (2.1-2.4) were higher than indeterminate types (2.0-2.2). Tomato paste, which were made of determinate type cultivars, showed high viscosity and serum viscosity.

We conclude that this result and further research would provide the possibility of processing tomatoes cultivation in South Korea. Based on this study, this would be used as basis data for the development of new processing tomatoes in South Korea.

### P1-3 THE USE OF FOLIAR APPLICATIONS OF ABSICISIC ACID TO REDUCE BLOSSOM END ROT IN PROCESSING TOMATOES

| Poster | P.A. Smith* and C.A. Argerich  
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Blossom End Rot (BER) in susceptible varieties of processing tomatoes can cause significant losses in marketable production, and consequently, economic damage to the grower. When using black biodegradable mulch, varieties of processing tomatoes susceptible to BER suffer an increase in proportion of fruit affected compared to bare soil conditions. The increase in production due to better root and soil conditions when using biodegradable mulch usually outweighs the losses from BER, thus, growers are not likely to abandon the use of biodegradable mulch.

Elongated Italian pear type cultivars of processing tomatoes used for premium whole peeled canned tomatoes are more susceptible to BER than blocky varieties. The percentage of fruit affected by BER increased fivefold (2.7% vs. 14.5%) between a susceptible cultivar without, and with biodegradable mulch respectively. Exogenous foliar applications of Abscisic Acid (ABA) at concentrations of 500 mg.l-1 in greenhouse tomatoes have been found to significantly reduce the incidence of BER. If the same results can be achieved in field processing tomatoes as in greenhouse tomatoes, an appreciable amount of money could be saved by producers using varieties susceptible to BER with biodegradable mulch. The objective of this study is to determine whether exogenous applications of ABA can reduce the incidence of BER in a susceptible cultivar, and if so, the economic viability of its use.

A trial was conducted in La Consulta, INTA Experimental Station in Mendoza, Argentina during the season 2014-15 on typical torrifluvent soils. The crop was distributed in single lines 1,5 m apart and drip tapes with emitters spaced 0,3m in the line. Black biodegradable mulch 22 microns thick was set over the planting bed seven days prior to transplant to ensure timely degradation. Daily water replenishment was done by a single surface tape in the middle of the bed.
that had a flow rate of 2.4 mm.h⁻¹ according to evapotranspiration tank type "A", adjusted by Kc. Fertilization consisted of poultry manure, 10 t.ha⁻¹ broadcast applied 50 days before planting supplemented by 25 U of N and 50 U of P equally in all treatments. A variety susceptible to BER was used: HM 3861. The experimental unit was a 5 m length of bed with 5 replicates in a totally randomized complete design. During the main fruit setting period of the crop (50 to 70 days after transplant [DAT]) foliar applications of ABA were used at five day intervals. Four different concentrations of ABA were used: 0 mg.l⁻¹ (Control), 100 mg.l⁻¹, 300 mg.l⁻¹, 1,500 mg.l⁻¹.

Total and Marketable yield, % of green fruit, rotten, sunburns, culls (fruit smaller than 40 g and fruit with defects), average fruit size, cracked fruit, soluble solids, pH, and BER index. These parameters were evaluated by regression tests among treatments at α= 0.05.

The results obtained in the field showed no statistically significant differences in any of the variables measured between treatments.

<table>
<thead>
<tr>
<th>Poster</th>
<th>P1-4 A FOCUS ON HIGH-LYCOPENE TOMATO CULTIVARS: HORTICULTURAL PERFORMANCE AND PHYTOCHEMICAL PROFILE</th>
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<tr>
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<td>Riadh Ilahy1*, Helyes Lajos2, Mohammed Wasim Siddiqui3, Gabriella Piro4, Marcello Salvatore Lenucci4 and Chafik Hdider1</td>
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Tomato (Solanum lycopersicum L.) is one of the most important agricultural crops all over the world being characterized by the presence of a plethora of natural health promoting antioxidant compounds including vitamins, phenolics (mainly flavonoids) and carotenoids (particularly lycopene). Either transgenic or conventional breeding methods have been used to increase the levels and diversify the profile of antioxidants in ripe tomato fruits.

The high-pigment (hp) tomato mutants facilitated this approach, representing useful genetic resources to be introgressed into elite cultivars (high-lycopene cvs) to simultaneously enhance the levels of different classes of antioxidants. Although several studies have been recently published on high-lycopene cvs, the information on their horticultural performances and phytochemical profiles is still lacking. In spite of the high content of lycopene, flavonoids and ascorbic acid, high-lycopene tomato cvs are claimed to have poor horticultural performances such as slow germination and seedling growth, high seedling mortality, low leaf coverage, brittle stems, low yield, reduced total acidity and soluble solids content, high sensitivity to various pathogens and premature defoliation, characteristics that limit their commercial acceptance. Therefore, the aim of this study was to assess the horticultural performances and phytochemical profiles of eight recently developed high-lycopene tomato cvs.

Experiments conducted in the Mediterranean region (Tunisia and Italy) showed that all the assayed high-lycopene tomato cvs (HLY02, HLY13, HLY18, Kalvert, Lyco1, and Lyco 2, including the latest developed lines HLT-F61 and HLT-F62) were vigorous with an excellent foliage cover and characterized by dark foliage and dark green immature fruits without morphological aberrations. Tomato yield ranged from 110 t/ha to 152 t/ha exceeding in some trials the yield of the elite industrial tomato cvs (Perfectpeel, Rio Grande and Donald).
The average fruit weight ranged between 70 to 93 g. The soluble solids content, an important processing trait for tomato, was comparable to or even higher than that of reference cvs (> 6 in some cases) and was associated with a suitable titratable acidity (0.381 for cv HLY 18). Besides those promising agronomic characteristics and high productivity, it should be mentioned that some ripe fruits of cv HLY 13 evidenced both radial and concentric cracks, which reduce their marketable value.

Regarding the phytochemical profiles, experiments from different geographical and environmental conditions confirmed that all tested high-lycopene cvs were characterized by an enhanced synthesis and accumulation of carotenoids, mainly lycopene and β-carotene (more than 280 and 20 mg/kg fw, respectively) as well as of other valuable health-promoting molecules such as phenolics, flavonoids and vitamins. Thus, the central role of high-lycopene tomato cvs in enhancing fruit pigmentation and functional quality, summarized in this report, justifies the extended efforts and breeding programs to decrease some initial adverse pleiotropic effects on their horticultural performances. Such efforts are leading to the selection of outmost quality marketable tomato lines suitable to meet the growing customer demand of healthy foods and tomato derived products.

The optimum crop production needs fertilization strategies that take into account the type of crop, soil conditions and weather as well as the actual practice of seed-fertilizer-irrigation-harvest by the farmer. As weather conditions and soil cultivation are independent farmer, only irrigation and fertilization can be altered by this Agriculture also affects the basis of their own future through land degradation, salinization, excessive water extraction and reduction of agricultural genetic diversity. However, the long-term consequences of these processes are difficult to quantify. If more sustainable production methods are used, they can mitigate the effects of agriculture on the environment.

This work is focused on to avoid or minimize the environmental impacts that nitrogen fertilizers causes in the crop or growing fields. Tomato crop is selected in “Vegas del Guadiana” growing fields for research. In order to minimize this impact, this project proposes to develop controlled release fertilizer glasses of macro and micronutrients so that leaching is according to the requirements of absorption of the tomato plant and no any other dissolving species could pass to groundwater and then preventing contamination.

The consortium of this project consists of two well-defined business and two R&D centers regarding objectives: Torrecid, SA, the company that have developed the new glass fertilizers, and Sociedad Cooperativa San Isidro de Miajadas, the user and analyze both its performance and environmental improvement achieved with them by cultivating 1 ha of tomato in 2015 campaign; Institute of Ceramics and Glass of the Higher Council for Scientific Research (ICV-CSIC, which have carried out the characterization of the leaching kinetics of macro and micronutrient fertilizers and CTAEX, Centro Tecnologico Agroalimentario Extremadura, that have studied the performance of the crop in order to compare the quality of the tomato fruit as well as the decrease in soil eutrophication and improving the environment. Between the two companies and two research centers it will conduct a detailed study of the entire project.
The project was carried out in one hectare of land in which half has been treated with traditional compact manure and the other half with the new fertilizer based on glass. Prior to application of fertilizer fund, the agricultural soil was analyzed. Later, after the sowing of the plants and their growing has been followed, foliar analysis, control of pests and weeds was made. From planting, the tomato plants are growing in relation to climate and genetic conditions. Setting the start of cultivation, as the plants were all sown and transplanted at the same time, the phenological development of varieties were also followed. Significant differences have been found in the B, Ca and Mn and Mg content in the plant according to the most suitable nutrient levels in tomato plants. Therefore, no significant differences have been found in the quality parameters currently analyzed in tomato fruits.

Concerning the yield of the tomato crops, it has been observed and proved an important increasing corresponding to the plot treated with glass fertilizer in an estimated quantity of 10000 kg/ha more than the yield obtained in the conventional fertilizer plot. These data should be taken into account carefully. The agricultural experiences should be repeated several years to confirm definitive results.

The granulometry of such soils is the same and is not changed by the addition of both conventional and glass fertilizer. Changes have been found in respect of the surface and the pore size of the particles that make up these soils.

Particles of soil fertilized with conventional fertilizer have lower specific surface than when soil is fertilized glass. For particles less than 50 microns surface area is 2.7 and 5.0 m2/g when using conventional or glass fertilizer respectively. The interpretation of these results is by now, somewhat complex.

The cost of this new glass fertilizers is higher than the conventional ones, but the idea is to elaborate the new products with glass residues and incorporate chemical elements with ashes from biomass boilers. This study shows that tomato crop in Extremadura with the new fertilizers could be a new line of environmental way of cultivating.

**P1-6 APPLICATION OF VIS-NIR REFLECTANCE SPECTRA FOR ESTIMATING SOLUBLE SOLID- AND LYCOPENE CONTENT OF OPEN FIELD PROCESSING TOMATO FRUIT JUICE FROM IRRIGATION AND MYCORRHIZAE TREATMENTS**

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The tomato (Lycopersicon esculentum L.) is one of the most important annual vegetable crops produced worldwide. More than 160 million tons of fruits are produced, in over 140 countries under tropical, sub-tropical and continental climates. The tomato production and consumption popularity trends show a continuous increase. In fresh- and processed tomato natural phytonutrients are also present, such as vitamins, pigments and the phenolic compounds which are considered to be responsible for a chemopreventive effect, of which the most significant is lycopene. Protective effects of lycopene- and food rich in natural phytochemicals on some types of cancer were suggested on the basis of epidemiological studies.

Most investigations have proved the effect of lycopene or tomato based diet on prevention of oesophagus, gastric, prostate and other epithelial cancers. Additional epidemiological studies have also suggested that lycopene may play a protective role against cardiovascular disorders. The measuring, categorizing and monitoring of these specific characteristics of quality parameters in the raw tomatoes and tomato-based products are extremely important both
for the processing industries and consumers. In this segment of the production and manufacturing the application of quick routine tests of spectroscopy are becoming more frequent. There are two important characteristics of the processing tomato fruit, the soluble solids content (Brix) and the quantity of lycopene, which are greatly dependent on the cultivar, environment condition, method of cultivation and maturity stage.

Approximately one-third of the quantity of world tomatoes produced is processing tomato which is available source of lycopene long-term to human population. Our results from this experiment suggest that different irrigation regimes and mycorrhiza treatment affects the important nutritional characteristics, such as soluble solids content and lycopene which are detectable in the VIS-NIR range. In this study we used Uno Rosso F1 processing tomato hybrid, and the experiment was carried out in the Institute of Horticulture- and Regional Knowledge Center of Szent István University in Gödöllő, Hungary. Fruits were produced in an open field experiment of processing tomato in 2012-13.

The experimental area was on brown forest soil; the mechanical composition was sand. The ground water level is under 5 meters below to the surface, so it did not affect the water absorption of tomato plants. Experimental growing technology was the same in both years and identical to that used by processing tomato farmers. The water doses were calculated from potential evapotranspiration, which depends on the daily temperature predictions. All processing tomato treatments received optimal (100) and 50% of optimum (50) water supply compared with rainfed control (C). Irrigation amount of daily irrigation demand was estimated from weather forecast data and plants were irrigated three times per week, by drip irrigation system. In addition to the different irrigation quantities we applied mycorrhizal treatment in the year 2013 on the optimal (100 M) and 50% of optimum (50 M) and on rainfed control (CM).

Spectroscopic and analytical measurements were performed on tomato fruit samples just after harvesting. The fruits were washed, cut and mixed, and 36 puree samples were used for analysis. The soluble solid content (SSC) value was measured using a digital refractometer, while pigments extracted with HPLC analysis a Chromaster Hitachi HPLC instrument consisting of a Model 5430 diode-array detector, a Model 5210 autosampler and a Model 5110 gradient pump was used. The spectroscopic measurements were performed with ASD FieldSpec® HandHeld 2™ spectroradiometer. This portable and laboratory used hyperspectral instrument is able to measure from 325 to 1075 nm spectral range, within a resolution of 1 nm.

In the two experimental years results of measurements show that the irrigation had a significant effect on soluble solids content. However, the mycorrhizal treatment in 2013 had a positive effect both on the soluble solids content and amount of lycopene which were reflected in the spectral values also.

Other recent publications have also shown the positive effect of mycorrhizal treatment in irrigated (100M) and non-irrigated (CM) plants on the red ripe fruit yield and fruit weight as well.
sustainable management. A classification of this type up until now has been lacking in Extremadura considering the importance of the climatic challenges which face the cultivation of the processing tomato crop. The tomato industry is one of the most important industries in the region accounting for some 21,674 ha of irrigated surface area last year (2014), with production over 1.4 million tonnes. (74.92% of Spanish national output).

Using data compiled from daily readings by the irrigation monitoring network of the regional council, a thermal index has been devised based on the climatic requirements of the processing tomato crop and which gives an average climatic profile of the area, with a high degree of homogeneity.

A total of 20 indicators were used including: average temperature, thermal integrals, the number of days with optimal temperatures per cycle and the different phases throughout the crop. To begin with a principal components analysis (PCA) was performed to limit discrepancies among the variables studied. Once the number of clusters was defined hierarchically, a non-hierarchical classification was performed to group stations into similar climatic subgroups. The results obtained give a clear image of the climatic differences and similarities of the area highlighting the most mitigating factors, whilst providing scientific mapping of the homogenous climatic zones.

Spain is currently ranked fourth in the world in terms of tomato production, after the United States, China and Italy. The main production area is in the region of Extremadura; where approximately 70% of all Spanish tomatoes are grown on over 22,000 hectares, other tomato producing areas in Spain include, Andalusia, Murcia and Navarra. 19 growers association process the harvest in 14 distinct tomato processing industries and have seen yields increase from 53 tonnes per hectare to over 93 tonnes per hectare.

This study references the yield statistics published by the Extremadura Regional Administration, ‘La Mesa del Tomate’ a non-profit collaboration of producers and industrial processors in Extremadura, and the Tomato News Magazine. In Extremadura tomato cultivation has gone from occupying 17,625 hectares in 2001 to 21,674 in 2014, reaching its peak in 2005 with 28,609, and a minimum of 14,235 in 2013. The average yearly production for the area is 2 million tonnes, rising from just over 1 million in 2001 to 1.9 million in 2014. This growth, far from being the result of a simple increase in the surface area cultivated, has more specifically been as a direct result of a substantial increase in the output of Extremadura farmers with yields almost doubling from, 56.41 t/ha in 2001 to 93.59 t/ha in 2014.

The number of growers in Extremadura has actually halved over the same period, going from over 2,300 in 2004 to just over 1,100 in 2014. The primary factor in this growth has been in the tomato yield itself, where output has almost doubled per farmer.

The tomato industry in Extremadura boasts a thriving and innovative culture. Outputs have been steadily increasing through the implementation of scientific methods, such as fertigation, and as the result of an ambitious and highly successful technology transfer program. This combined with a high concentration of ownership has placed Extremadura at the forefront of tomato production worldwide.
The tomato is a major vegetable crop in the world, with more than 150 million tons produced annually, of which about 25% goes to industry. Of this fraction, more than 70% goes to tomato paste (ODEPA, 2013). Although, this vegetable has a long history in Chile, there are still some problems that keep down the sector’s productivity. This study aims to control a very polyphagous fungus named Alternaria which is currently a major problem for the Chilean tomato industry since it finds a favorable growth environment in the productive areas located in south central Chile. According to information collected, this problem causes the loss of up to 15% of the production of tomatoes causing enormous economic damages.

Traditional control mechanisms are based on scheduled fungicide applications; which may not coincide with environmental conditions that favor the development of the fungus, leaving the tomato unprotected. However, technological advances have allowed agricultural production to incorporate advanced predictive methods for the development of integrated strategies directed to fungal disease management, based on models that integrate both climate data and development of the pathogen to predict risk level, considering favorable conditions for disease development. These tools have been applied to various plant species in the world and have showed to be effective in improving disease control; allowing also to reduce the number of fungicide applications.

In this paper we present preliminary results of the development and validation of an early warning pilot platform to control the presence of this fungus as a support tool to a group of suppliers to the company SUGAL Chile. This technology will allow in the medium term to offer to industrial tomato growers an information system to support decision-making in the application of pesticides and integrated management of this disease.

Climate information was gathered and indicators of the presence of the fungus (spore count) for two seasons (2014-15 and 2015-16) in two representative productive areas were collected to design the tool. Results were contrasted among different treatments that included traditional treatments based calendar and treatments based on proposed alert models. An early warning system was proposed based on Tomcast model.

This model was introduced in Canada in 1985; from the previous FAST alert model for fungal diseases of industrial tomato, which predicts the presence of the disease. TOMCAST identifies weather conditions (temperature and humidity of the leaf) that make favorable the development disease. In addition, preliminary results are presented to show a p-days model and a predictive model based on data mining. P-days is a widely used model on potato’s early blight, and also belongs to a group of models that conform a pioneer alert system in Chile.

Finally, the paper contrasts the information obtained in the field (presence of spores of A. alternata) with the climatic conditions of the area under study to identify and/or validate conditions that make favorable development of the fungus, the presence or potential for disease development.
Bacterial canker (causal agent: Clavibacter michiganensis subsp. michiganensis) occurs yearly in Michigan, United States. Tomato productivity and fruit quality are affected causing great economic losses for growers and the local processing industry. Disease symptoms depend on plant age; when infected as a seedling, plants can wilt and die. Less severe infections on transplants include blistering on the petiole and browning of the mid-vein. Infected transplants can also appear healthy and not show symptoms. When older tomatoes become infected, leaflets may display unilateral wilting and marginal necrosis commonly referred to as “firing”. Vascular tissue may be discolored when disease is advanced. Infected fruit have “birds-eye” spotting. Michigan growers and processors have managed bacterial canker as it occurs in the field.

The present research focused on transplants in the greenhouse because the spread and increase of bacteria are favored by wet, humid conditions and close plant spacing. Multiplication and spread of the bacterium may be reduced on plants in the field due to reduced relative humidity, air movement, and increased plant spacing. It is more economical and efficient to spray transplants while in the greenhouse than to treat plants in the field. Trials were conducted in a commercial greenhouse using 288-plug plant trays of tomato transplants. Fungicide treatments were applied to transplants as soon as the first true leaves were visible. Subsequent sprays were applied every five days until the transplants were removed from the greenhouse and planted in the field. Prior to moving plants out to the field, samples were taken within each block to determine how far the bacterium had spread from the infected plants that had been placed within each block.

Results of one greenhouse study using tomato seedlings showed that copper hydroxide alone or mixed with streptomycin limited bacterial canker compared to acibenzolar-S-methyl (ABM) alone or ABM + copper hydroxide; all treatments were better than the untreated inoculated control. Adding copper hydroxide to ABM significantly limited pathogen populations compared to ABM alone.

In a second greenhouse study with tomato seedlings all treatments limited pathogen spread compared to the untreated control. Seedlings treated with copper hydroxide were similar to those treated with ABM or streptomycin. Also, seedlings treated with ABM had similar reductions in bacterial canker populations as those seedlings treated with streptomycin. The diseased plants produced a significantly smaller yield than the healthy plants. Fruit produced by the diseased plants were smaller than those produced by the healthy plants. Plants treated with copper hydroxide, copper hydroxide + mancozeb, streptomycin, and streptomycin + copper hydroxide and exposed to bacterial canker yielded similarly to the healthy plants and produced full-sized fruits.

Results suggest early and frequent applications of these treatments can limit the spread and increase of bacterial canker among tomato transplants in the greenhouse. Further, it appears that these fungicide applications in the greenhouse can increase the yield in the field compared to untreated diseased plants.

The results of our study show that even under severe disease pressure, applying copper hydroxide alone or in a combination with mancozeb at 5-day intervals to transplants in the greenhouse once true leaves have emerged results in transplants that produce yields comparable to that of healthy plants. Streptomycin and ABM were also effective. Continued treatment in the field may be warranted, especially when weather conditions favor continued bacterial development.
Field research studies included tomato 'Mountain Spring' plants that were hand-transplanted into plant beds. Each row comprised of two treatments, 6.9 meters long with a 1.5-meter section in the middle that was reserved for inoculated plants. Treatments consisted of copper hydroxide, hydrogen dioxide, famoxadone + cymoxanil alternated with copper hydroxide, and ABM plus an untreated control. Treatments were applied preventively and then reapplied every 5 days through the growing season. All treatments were sprayed from the center of the row outward to encourage natural spread of disease from the inoculum source. In this study, bacterial canker spread 5.5 meters in 3 weeks. Bacterial canker was lower for the ABM-, copper hydroxide- and famoxadone + cymoxanil-treated plants compared to plants treated with hydrogen dioxide or the untreated diseased plants. Foliar disease symptoms of hydrogen dioxide-treated plants were statistically similar to the untreated diseased plants. ABM and copper hydroxide offered superior control of bacterial canker foliar symptoms compared with either hydrogen dioxide or the untreated diseased plants. Famoxadone + cymoxanil alternated with copper hydroxide effectively suppressed disease symptoms and was shown to be helpful in managing bacterial canker.

P1-11 EVALUATION OF THE ACYBENZOLAR-S-METHYL EFFECT, ALONE OR COMBINED WITH AZOXYSTROBIN, ON THE CONTROL OF BLOSSOM END ROOT IN TOMATO INDUSTRY CULTIVATED IN TWO DIFFERENT WATER REGIMES

Poster

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Acybenzolar-S-Methyl (ASM) is a functional analogue of salicylic acid involved in the mechanism of the systemic acquired resistance (SAR), most probably through the specific induction of expression of a pattern of proteins involved in defense mechanisms/stress responses, photosynthetic metabolism and energy metabolism. It has also been hypothesised that ASM increases the resistance of plants against abiotic stresses such as drought, cold, heat and salinity.

In a preliminary study, we reported results about the effect of the ASM on the blossom end rot (BER) of processing tomato cultivated under water stress. In order to deepen the effects of the molecule on protection against abiotic stress, a field trial was carried out in 2013 and repeated during 2015 crop season at the "Centro per la sperimentazione e valorizzazione delle colture mediterranee" of Syngenta, in Foggia (southern Italy). A processing tomato hybrid ('Ulisse') was cultivated combining two irrigation treatments and six chemical applications.

Processing tomato was planted in coupled rows. Irrigation was performed using a drip system. Two irrigation treatments were studied: 100% (full irrigation) and 75% (percentage restitution of water in respect to 100%). Soil moisture sensors were used to schedule irrigation at the depletion of 30% of available water content and the water applied was measured with a flow meter. Six chemical applications were: T1 - check (no added of any chemical), T2 - drench in nursery with acybenzolar-S-methyl (50%) (0.03 g f.w./l) + six foliar distributions of acybenzolar-S-methyl (50%) (50 g/ha for each distribution) along the crop cycle; T3 - six foliar distributions of acybenzolar-S-methyl (50%) (50 g/ha for each distribution) along the crop cycle; T4 - drench in nursery with acybenzolar-S-methyl (50%) (0.03 g f.w./l) + three foliar distributions of acybenzolar-S-methyl (50%) (50 g/ha for each distribution) + three foliar applications of azoxystrobin (250 g/l) (1 l/ha for each application); T5 - three foliar applications of acybenzolar-S-methyl (50%) (50 g/ha for each application) + three foliar applications of azoxystrobin (250 g/l) (1 l/ha for each application); T6 - three foliar...
applications of azoxystrobin (250 g/l) (1 l/ha for each application). A split-plot design with four replicates, consisting of
the irrigation treatments in plot and the chemical applications in sub-plot, was used. At harvest marketable tomato
yield and blossom-end rot incidence were evaluated for ten plants per replicate selected randomly. All data were
analysed using analysis of variance (ANOVA). The significant differences among the mean values were calculated
following Tukey test.

As expected the water regime significantly influenced the BER incidence having the 75% regime an average number
of BER higher than 100% (5 vs 1). Relative to the chemical application, the best result was achieved by T4 (drench in
nursery with ASM + three foliar applications of ASM + three foliar applications of azoxystrobin) that showed the lower
number of fruit with BER (about 2 on the average of the two water regime). Of particular interest it the behaviour of
the treatment T4 based on the two water regimes, showing the lowest number of BER both under 100% and 75%
water regime (0.5 and 3) with respect to the other treatments. In particular, under stressed condition, T4 showed a
number of fruit with BER about 57% lower than T1 (check), 34% lower than T6 (three foliar applications of azoxystrobin
along the cycle), 31% lower than T5 (three foliar applications of ASM + three foliar applications of azoxystrobin), 28%
lower than T3 (six foliar applications of ASM along the crop cycle) and only 9% lower than T2 (drench in nursery with
ASM + six foliar applications of ASM along the crop cycle).

These results suggest a favourable response to the drench in nursery with ASM on the incidence of BER under water
stress condition when the ASM is combined with azoxystrobin along the cycle.

Remote piloted aircraft (RPA), also known as unmanned aircraft systems (UAS), are increasingly used in agriculture
for remote inspection of crop areas, sensing of crop and field conditions and for tracking of assets such as vehicles,
personnel and materials. While technically capable of transporting and dispensing a payload such as agrochemicals,
the use of RPA for such missions is much less common due to current regulatory and design constraints. In the work
presented here, a commercial RPA-mounted spray system was deployed for agrochemical application to commercial-
scale croplands in California, USA. Preliminary studies determined the productivity of the RPA for spraying; specifically,
depending on the swath width used and the flight pattern in the field, the RPA could achieve 2.0 to 4.5 ha hr-1 work
rates while applying volume rates of 15 to 50 l ha-1.

During the 2014 and 2015 growing seasons, the RPA was used to provide season long application of agrochemicals
to the test vineyards. The spray system was successfully used for spray applications at 7 to 14 day intervals over two
growing seasons. Measurements of fungicide deposition documented spray performance relative to a standard
ground-based application at 935 l ha-1. Spray applications from RPA operations were shown to be a useful supplement
to ground-based applications in high-value crops.

The experimental results observed and presented in this paper and the multi-season use of the RPA helicopter support
the following conclusions:

- Remotely piloted aircraft systems can be successfully deployed in specialty crop spraying conditions throughout
  the growing season.
• Spray application rates on the order of 50 l ha\(^{-1}\) can be achieved and used for application of standard agricultural chemicals in tank mixes including liquid and wettable fungicides, insecticides, flowable sulphur and adjuvants.
• Spray deposition rates from RPA applications can be similar to those achieved by ground based sprays. However, in late season applications deposition in the lower portions of the crop canopy and the fruit clusters can be less than that achieved by ground spraying.
• RPA spray applications are likely to be used as a supplement to ground-based spraying, particularly in early season and light canopy applications.
• Operator skill is required for unmanned aircraft spraying; however, use of on-board vehicle stabilization systems and aided by autonomous operation, can reduce operator work load and required skill.

The results from this study provide a multi-season insight into the potential commercial deployment of unmanned vehicles for specialty crop spraying in a high value crop environment. Spray deposition rates were comparable to those typically observed in ground-based spraying, particularly in early season use. Sprayer work rates achieved were in excess of those typical with ground-based vehicle spraying in grape production. Therefore, in the tested conditions, RPA spraying could provide hybrid performance that includes beneficial aspects of both manned aerial spraying (high work rates) and ground-based spraying (ease of deployment). Detailed analyses of economic return from RPA spraying is challenging due to lack of information on vehicle costs, hours use expenses and the regulatory requirements for operators and associated field personnel.
transplanted in April, at a planting density of 30000 plants/ha, using a mechanical transplanter (Fialho, Tex Driver). The tomato variety used was H (Heinz)-9661. The crop was grown according with the Organic Farming Regulation (Regulation (CE) 834/2007 of European Commission). During the vegetative development of the tomato crop (some days before the harvest), the chlorophyll content of the tomato plants was measured to evaluate the nutrition level of the crop. The tomatoes were harvested manually from the trial plots when the 80% of them were red and ripened. The tomato plants were cut off at the base and shaken to make fruits fall into labelled plastic boxes. These tomato samples were used to work out the agronomic and quality parameters. Besides that, sensory evaluation was performed.

Chlorophyll is the main photosynthetic pigment of plants and their content in leaf depends on foliar nitrogen concentration. SPAD measures of different treatments were found within a high reading range (39.75 to 47.46 units). Tomato plants from the highest dosage treatments showed the highest values of chlorophyll content. These results are consistent with the N fertilizer dosage applied and the observations in field during the crop cycle. The total yield obtained ranged between 55 t/ha (TD5) and 102 t/ha (TD4) for the different treatments.

The treatment that applied 300 N (TD4) showed the highest Total yield values and was significantly higher than those obtained for control treatment (TD5). TC treatment showed 77 t/ha, while TD1, TD2 and TD3 produced respectively 81, 84 and 87 t/ha. It can be observed that the more N applied, the more Total yield obtained. Regarding the mean weight of one fruit, significant differences were not found among the treatments. No significant differences were found for green, over-ripened, sun damage and blossom-end rot fruits. The quality parameters of processing tomato were not affected by the application of sheep wool as organic fertilizer. Through the Sensory Analysis, we studied several parameters: colour, pulpy texture, synaeresis, odour, taste, acidity, sweetness and viscosity in mouth. The tomatoes were presented as tomato paste. According to the obtained results, sample from control treatment was best evaluated for all the attributes. This sample showed good values of pulpy and viscosity, colour and sweetness.

All in all, it was demonstrated that sheep wool application as organic fertilizer at the highest doses allowed obtain the highest yields, for processing tomato under organic farming growing conditions. The results suggest that sheep wool can be used successfully as alternative biofertilizer, at a doses of 2000 kg/ha (200 N) for processing tomato in a sustainable and environmental friendly way.

**P1-14 EGYPTIAN BROOMRAPE ERADICATION EFFORT IN CALIFORNIA: A PROGRESS REPORT ON THE JOINT EFFORT OF REGULATORS, UNIVERSITY, TOMATO GROWERS AND PROCESSORS**

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Egyptian broomrape, Orobanche aegyptiaca, was first detected in a commercial processing tomato field near Davis, California in the summer of 2014. This was the first report of this species in the United States, from which we presume was an introduction. This parasitic weed is a major pest in several countries including Israel and Italy as well as over a dozen other countries in the Middle East, Eastern Europe, Asia and Africa. Egyptian broomrape has a wide host range including 30 crops. Infestations can have severe economic impact; as an example, yield reductions of 50% have been reported in watermelon. Egyptian broomrape seeds are believed to survive as long as 30 years in the soil. The infested tomato crop was voluntarily sprayed with glyphosate when both crops were in the flowering stage to terminate growth of the host as well as to prevent further seed production of the weed. The distribution within the field was somewhat widespread and included several highly infested areas. To prevent spread to other fields, the California Department of Food and Agriculture (CDFA) placed the 20-hectare field under quarantine with guidance from the United States Department of Agriculture (USDA).
The grower together with the processing tomato industry through the California Tomato Growers Association (CTGA), tomato processors, University of California Cooperative Extension and CDFA’s Emergency Fund program initiated an eradication project with a target of control by fumigation.

The cost of the fumigation approached $10,000 US per hectare, far in excess of any expected economical return for the grower. The eradication effort included limiting vehicle and foot traffic into the field, sanitation procedures for equipment leaving the field, propane flaming, fumigation by a private applicator and subsequent field monitoring by CDFA through the local county Agricultural Commissioner’s office.

A susceptible host-crop planting sequence was developed to monitor for the possible escape of broomrape plants following eradication treatments. Three, host-crop plantings without detection of escape broomrape would be required before the quarantine would be lifted. Currently, no California tomato processor will accept tomatoes from a quarantined field area because of the risk of region-wide spread with the many fruit transport containers should O. aegyptiaca seed contaminate the recirculated, bulk rinse water used to unload incoming fruit from an infested field. The field passed the first inspection of a host crop without incidence following fumigation. Without emergence of broomrape in subsequent host crops, the quarantine will be lifted as early as late fall 2016.

Other procedures in the project included a growth chamber screening of potential commercial crop hosts, an evaluation of efficacy of propane flaming and a limited planting of tomatoes in highly infested areas post fumigation. Discussion will include possible action plans if eradication is unsuccessful.

The experiments on effect of plastic mulch and tillage method on yield, yield components and quality of tomato (Lycopersicon esculentum) was carried out at experimental field of Agri. Centre of Excellence, Fieldfresh Foods Pvt. Ltd, Ludhiana Punjab during 2013 and 2014 growing seasons (30097° latitude and 75° 79’ longitudes). The soil of the experimental field was sandy loam in texture. Chemical analysis of the soil (top 15cm) showed a pH of 8.2, 0.48% organic carbon, 182.4 kg/ha permanganate extractable nitrogen, 24 kg/ha Olsen’s (0.5 M NaHCO3) extractable phosphorus and 192 kg/ha exchangeable potassium with a EC of 0.15 mmho/cm. Total rainfall and evaporation received during the crop season was 328.2 mm and 241.1 mm respectively.

The experiment was laid out in split plot design. Mulch levels in the study were plastic-mulching (PM; black plastic mulch) and no-mulching (NM) while tillage treatments were conventional tillage (CT; moldboard plowing * two passes of disk harrowing), minimum tillage (MT; one pass of disk harrowing) and no-tillage (NT). Yield, yield components (number of plants per hectare, NPPH; number of fruits per plant, NFPP; fruit weight, FW; fruit length, FL; fruit diameter, FD) and one quality parameter (total soluble solids, TSS) were determined for all treatments.

Results showed that NPPH and NFPP were the most important yield components explaining yield difference under the different mulch levels and tillage methods. The maximum NPPH (10760), NFPP (18.3) and as a result yield (11.9 ha-1) were observed when black plastic mulch was applied, while maximum values of FW (68.6 g), FL (66.5 mm), FD (57.0 mm) and TSS (6.51%) were noted in case of no-mulching plots. In contrast, minimum NPPH (7385), NFPP (14.5) and hence yield (7.50 ha-1) were obtained with no-mulching plots, while the minimum values of FW (61.7 g), FL (63.9 mm), FD (56.3 mm) and TSS (5.25%) were noted in case of black plastic mulch treatment. Moreover, the...
maximum NPPH (12036), NFPP (20.9) and consequently yield (15.1 ha-1) were observed with plowing + two passes of disk harrowing, while maximum values of FW (68.3 g), FL (69.7 mm), FD (59.6 mm) and TSS (6.67%) were noted in no-tillage plots. Conversely, minimum NPPH (6310), NFPP (12.6) and hence yield (5.51 ha-1) were obtained with no-tillage plots, while the minimum values of FW (61.5 g), FL (60.7 mm), FD (53.8 mm) and TSS (5.63 %) were noted in case of plowing + two passes of disk harrowing treatment.

On the whole, for reaching the highest yield and enhanced quality of tomato the integrated use of mulch and tillage can be recommended.

In recent years, processing tomato growers have been faced with a new problem, the appearance of blind transplants. This problem may be observed at first, but usually the symptoms are not easy to observe, and only after a period, the grower identifies the symptoms. Preliminary studies suggest that the use of priming (pre-germination treatment, based on the seed water imbibition) may contribute to the appearance of blind transplants. Thus, this study aimed to evaluate changes in tomato seedlings from primed seeds. Seeds from the two parental lines and the F1 hybrid were submitted to priming in aerated solution of KNO₃ (3%), under light, at 20 °C for nine days and subsequent germination and seedling emergence under greenhouse conditions. To include experimental design and statistical analysis.

There was a higher incidence of blind transplants in those primed seeds compared with no-primed seeds. This effect was apparently genotype-dependent since the two parent lines significantly diverged to the frequency of defective plants.

The vigor tests are tools necessary for the determination of the physiological potential of a seed lot. The objective of this study was to assess the effectiveness of a computerized system for seedling image analysis to determine the processing tomato seed vigor after different periods of aging. BRS Sena, a processing tomato hybrid from Embrapa Vegetables was used in this study.

Seeds were placed in aging chamber for 0, 24, 48, 72 and 96 hours in 41°C and 60% RH, under dark conditions, generating five seed lots. After this period, seeds were submitted to the first count, germination, seedling emergence and the Seed Vigor Imaging System - SVIS® test. The tests were carried out in a completely randomized design with four replications and the data were subjected to analysis of variance, and the means comparison was done by Tukey’s test (p ≤ 0.05). The computerized analysis system provided data on the vigor index, uniformity of development and seedling growth, after the fourth day of the germination test. The result obtained by computer analysis SVIS® was similar to the results of other vigor tests used in the study, detecting significant differences between the vigor index, length and uniformity of seedlings. This result demonstrates that the computerized analysis system of images may be a viable alternative for obtaining reliable information on the physiological potential of tomato seeds.
A major problem faced by the tomato growing and processing industry is the accumulation, handling and disposal of processing wastes. Currently, most of the tomato residues are either used as fertilizer or disposed at landfills with its inherent carbon footprint and commercial costs. A promising treatment of tomato production waste is the production of biogas via anaerobic digestion (AD). During the AD process, approximately 50-70% of the chemical energy conserved in the tomato organic matter can be converted into methane gas, allowing up to 99% of the total weight of plant material to be digested, leaving <1% of waste solids. In particular, methane production from tomato waste is a complex, multi-step process that involves multiple syntrophic interactions.

The lignocellulosic matrix present in the plant tissue is difficult to degrade. This is in part the focus of the present research: evaluating the operational conditions that allow maximizing the methane production in biogas.

The experiential work has been carried out within the framework of the FP7 project: “High Value Plant Products – From discovery to final product”, #613513. The methanogenic potential of tomato plants, expressed as the amount of methane produced, were performed at laboratory scale (0.1 L), operating at anaerobic mesophilic conditions using different substrate concentrations and different types of inoculum. Methane production and its content in the biogas were measured by GC-TCD and a complete characterization of the physicochemical properties of tomato residues has been performed. Furthermore, comparisons between dry fresh and autoclaved samples have been performed. So far, best results have been obtained using inoculum from a wastewater treatment plant and the tobacco industry, showing maximum methane productions at total solid concentrations of 0.5, 1.0 and 3.0%. Methane production ranged from 200 to 600 mL CH₄/g volatile solids content (VS).

These values are similar to those reported previously for tomato residues, (Saev et al., 2009, Atem et al., 2010, Vintila et al., Chicatto-Gasperín et al., 2014). No significant difference was observed between autoclaved and non-autoclaved residues. Methane productions decreased between day 15 and 20, achieving 80% of the total methane accumulated after 30 days of the process. Substrate concentrations of 1% and 3% showed highest methane concentrations (30-40%) in the biogas.

These results set the base for the scale-up and integration of biogas plants in association with tomato processing or other food production facilities. The aim is to add value to the food production process by using its waste materials in two general forms: (1) by producing thermal and electrical energy for maintaining the greenhouse operations when biogas is combusted, and (2) by recovering water and nutrients from the digestate that can be further used as fertilizer for tomato crops.
In the industrial processing of tomato paste using Cold Break conditions, the products are typically concentrated to 30/32 Brix or 38/38 brix known as double or triple concentrated tomato paste. Finish screen size typically ranges between 0.033 inches (0.84 mm) to 0.060 inches (1.52 mm) leading to a fine or coarse finish levels in the resultant juice. Tomato pulp and products made from tomato pulp are a complex mixture of soluble solids, insoluble solids and water. The soluble solids in solution are primarily simple sugars, organic acids and mineral ions. The insoluble solids range from simple lipids and proteins to macro molecules such as pectin and cellulose, to cellular level structures, such as cell walls, all the way up to visible peel and seed fragments.

The most common methods for reporting the concentration of tomato paste includes Brix, Squeezed Brix (SQ Brix) and Natural Tomato Soluble Solids (NTSS). Total Solids (TS) is a much less common method for reporting concentration commercially within the processing tomato industry.

NTSS is typically the measure of soluble solids in the serum of tomato paste, where the interference from Insoluble solids is overcome by using centrifugation. The soluble solids in the serum are measured using a calibrated refractometer. The rational for measurement of squeezed brix is to “partially” eliminate the interference of the insoluble solids in tomato paste by squeezing tomato paste using a “muslin cloth” or “filter paper” directly on to the prism of a refractometer. This method is in particular used in Europe. In most of the other countries, the soluble solids are measured by directly applying a suitable quantity of tomato paste directly on the prism of a refractometer. This leads to the highest “interference” in the measurement of soluble solids in tomato paste. The differences in the methodologies followed are due to lack of infrastructure (such as ultracentrifuge) and training that is required in the measurement of NTSS. Commercial transactions of tomato paste from the United states is typically done on the basis of NTSS levels, whereas in Europe, Africa & China, Brix or squeezed brix are often the basis for commercial transactions, which sometimes leads to difficulties in valuation based on expression of concentration used.

The difference between the measured values between the three methods is primarily driven by the amount of insoluble solids retained in a given sample. The primary driver for the amount insoluble solids is tomato variety, screen size during refining & concentration of the product. The objective of this study was to understand the correlation between Brix, SQ Brix and NTSS in CB tomato paste, so as to reliably estimate each other based on a single measurement.

We measured Brix, Squeezed Brix, NTSS and Total Solids in 2 concentrations and 2 finish screen sizes within CB tomato paste over 2 processing seasons using standardized methods.

The analysis of the data provides a co-relation which enables the estimate of Squeezed Brix & Brix from NTSS data. Squeezed Brix and Brix can be reliaablliy estimated from NTSS data for cold break tomato paste. The reliability of the estimate is the highest for lower concentrations such as 30/32 Brix and the reliability of the estimate is lower as the concentration increases to 36/38. Concentration of the product has a greater influence compared to finish screen on the reliability of the estimated Squeezed brix and Brix from NTSS.

In general, estimates of SQ Brix from NTSS will be more reliable than the estimates of Brix from NTSS.
At the heart of the “Extremadura” Agrofood Technology Center lies its technology transfer policy as can be witnessed by its successful implementation in the local tomato industry where yields have almost doubled, and at our own sites where researchers trial varieties and cultivation techniques, in addition to production technologies, in conjunction with La Mesa Del Tomate, a non-profit organization, which brings researchers, growers and processors together. In 2006 the CTAEX Office for Transfer of Research Results launched the Tomato Technology Observatory, a technology vigilance tool serving as a channel for both growers and processors to gain access to the latest developments in the sector.

Through a comprehensive system of research and rigorous validation of documentary sources CTAEX has been responsible for the development of the Tomato Technology Observatory an information service compiled from scientific articles, journals, patents and legislative frameworks in addition to in depth market analysis. This comprehensive resource is presented as a website, featuring the latest trends, customized alerts along with a printed magazine, allowing growers and the industry as a whole to access up to the minute trends and production forecasts at both regional and global level with a view to optimizing performance and sustainability. One of our most important activities is the identification of high-value emerging markets through a systematic analysis of the United Nations UN Comtrade database (International Trade Statistics Database), to predict areas of added value in emerging markets and technologies.

According to global trade statistics published by the United Nations on the UN Comtrade database, world tomato exports reached 5.6 million tonnes in 2014, with a net value of 6,319 million dollars, the main exporting countries being, The United States, China, Italy, Spain and Portugal. In addition, the information provided on R & D patents has resulted in the Community Research and Development Service (CORDIS) which from 1990-2015 registered 234 research projects which referenced tomatoes directly in the description, the vast majority of those being involved with crop production. With reference to patent registration, according to the World Intellectual Property Organization's database, the country with the most registered patents is the United States followed by Canada for international patents and European patents. If we zero in on the sector with the most registered technologies, we will see that by far the largest comes from agriculture and from food technology in general, including food preservation treatments, new technologies for creating plant based materials and crop resistance and disease defence.

In addition to increasing the income of growers and processors in Extremadura, this tool is contributing to the professionalization of the industry through the dissemination of new and relevant innovation in the agrofood sector.
The recent greater attention toward hygiene, safety and environmental problems is requiring food industries to adopt eco-friendly, safe and more sustainable packaging for the consumer. Problems of food's contamination and of substances' migration from packaging are always focus of attention. Environmental sustainability forces businesses to look beyond making short term gains and look at the long term impact they are having on the natural world. The considerable emphasis on the recovery, recycling and upgrading of byproducts is part of this trend. In fact, by-products pose increasing disposal and potentially severe pollution problems and represent a loss of valuable biomass and nutrients that can be recovered and be upgraded to higher value and useful products, according to the Waste Framework Directive, that sets more ambitious targets for the re-use, recycling and recovery of some categories of waste.

The project, entitled Development of bio-based coating from tomato processing wastes intended for metal packaging (BIOCOPAC) aims to meet these demands by developing a novel bio-lacquer for metal food packaging produced from tomato by-products. The tomato processing industry, one of the most important in Europe, produces thousands of tons of waste, which are only partly reused and which contribute to pollution. On the other hand, the metal packaging industry in general and for food in particular, uses coatings obtained from oil for the protection of containers, depleting natural resources. It should be then considered that the production process of the synthetic resins used for food coatings, mainly epoxy based, are processes generating high CO2 emissions.

The BIOCOPAC project develops a natural lacquer from the tomato skins. The starting substance for the production of the lacquer is cutin, a component of the cuticle of the tomato skins. The project is based on the extraction of the cutin from tomato peels. The composition of tomato skins' cutin has just been extensively studied, it consists of some n,16-dihydroxyhexadecanoic acids where the 10-isomer is largely dominant. The tomato cutin is a polyester biopolymer interesterificated with potential to replace petroleum for the synthesis of polymer.

The research started with the analysis and characterization of the tomato waste, it continued with the setting up, the optimization and standardization of an experimental method to extract cutin from tomato peels. Finally, the Consortium is developing the resins and the formulations for different cutin-based bio-lacquers applicable to metallic materials.

A national and international patent related to the industrial process for the Extraction Procedure was registered: WO 2015/028299A1; PCTEP20146187. The partner SALCHI was interested in the patent of new lacquers for producing of an innovative bio-based natural lacquer from tomato waste, thus offering the possibility to manufacture high quality metal cans coated with a sustainable and ecofriendly novel coating. All SME partners have promoted, for commercial use, the new type of packaging, its environmental and health advantage and this new way to use the tomato wastes, to farmers, customers and consumers and their associations. In this way, they are obtaining commercial and marketing advantages over their competitors in the market. In particular, Salchi has received many requests for information on the new lacquer, especially requests about the time-to-market expected for the new bio-lacquer.

The formulations have been applied on different metallic substrates (tinplate, tin free steel and aluminium; roughly 5 g/m² of dry film weight). The results obtained showed good values of chemical resistance (MEK test), good adherence (tape test), good mechanical properties and a good resistance to thermal sterilization in water.
Background
Guanosine is a natural bioactive compound and endogenous nucleoside that has been identified from tomatoes (Solanum lycopersicum). Guanosine exhibits antiplatelet activity. However, the specific mechanisms by which this inhibition occurs is not completely established.

Aims
The main aim of this work is to investigate antiplatelet action mechanisms and antithrombotic activity of guanosine.

Methods
Guanosine (10 to 500 µmol/L) was evaluated on i) Platelet P-selectin expression and GPIIb/IIIa activation by flow cytometry, ii) Platelet ATP secretion and aggregation induced by ADP, collagen and arachidonic acid, iii) Platelet adhesion and aggregation under controlled flow conditions, iv) Intraplatelet cAMP levels and release of sCD40L, IL-1β, TGF-β1 and CCL5, v) Phosphodiesterase 3A (PDE3A) activity and phosphorylation of the cAMP-dependent Protein Kinase (PKA), and vi) Antithrombotic activity (200 mg/kg) in a murine model. The protocols were authorized by the ethics committee of the Universidad de Talca in accordance with the Declaration of Helsinki.

Results
Guanosine concentration-dependently (10 to 500 µmol/L) inhibited P-selectin expression and GPIIb/IIIa activation, platelet ATP secretion and aggregation induced by ADP, collagen and arachidonic acid, and diminished platelet adhesion and aggregation under controlled flow conditions on collagen. At these concentrations guanosine significantly decreased the release of inflammatory mediators from platelet activation (sCD40L, IL-1β, TGF-β1 and CCL5).

Furthermore, guanosine increased intraplatelet cAMP levels/PKA activation. Moreover, guanosine had a potent antithrombotic activity.

Conclusion
Antiplatelet and antithrombotic effects of guanosine are associated with cAMP/PKA signaling pathway.
Introduction
The growing demand for practical and healthier food sources is challenging researchers to find natural sources for sustainable and healthier added ingredients. The tomato industry currently produces enormous quantities of tomato seed and peel, which although nutritionally rich are at present not utilized for human consumption. A variety of research has been conducted on how best to utilize these byproducts; however, the majority of these studies have until now focused on the manufacture of breads, food oils and animal feed.

The objective of this study therefore was to re-evaluate current tomato industry byproducts for the development of IFPs as texturing agents and food improvers for tomato products, while also improving both fibre and lycopene values.

Methods
A fried tomatoes sauce was developed in which the standard concentrate was replaced using the recently developed IFPs. The manufacturing process is as follows, mix ingredients, homogenise, heat to 90ºC, bottle in glass and pasteurize in water at atmospheric pressure for 40 min.

In the first trial a variety of different IFPs were used for the manufacture of tomato sauce (without removal of starch agents but with substitution of the standard concentrate); prepared with a HOT concentrate (enzymatic inactivation 80ºC) with 5%, 10% dried peels and seeds, a COLD concentrate (enzymatic inactivation 60ºC) with 5%, 10% dried skins and seeds, a HOT concentrate with 5%, 10%, 20% y 30% skins and seeds blended, and a COLD concentrate blended with 5%, 10%, 20% and 30% fresh skins and seeds.

In the second trial, the same IFPs were used as in the first (HOT concentrate 5%, 10% and COLD 5% y 10%) to prepare fried tomato but where starch was completely eliminated.

In a third trial skins and seeds were added to the sieved tomato pulp and blended in concentrations of 20%, 30%, 50%, later concentrated using a HOT treatment. The IFPs obtained were then used to create a fried tomato where the starch had been completely eliminated.

A subsequent sensorial testing was conducted to evaluate a range of attributes, aspect, colour, flavour, texture and acceptance, on a scale of 1 to 7 where 1 is strong dislike.

Results
The conclusion obtained from the first trials was that IFPs with skins and dried seeds were not suitable for mixing with fried tomatoes sauce in that the resulting flavor and mouth sensation were unpleasant. The same was true of the IFPs with fresh skins and seeds blended in concentrations of 20% and 30%. In contrast, concentrations of 5% and 10% gave positive results.

In the second trial, the taste tests indicated that fried tomato prepared with the COLD concentrate, IFPs with no added starch, were too liquid and had an unacceptable texture. However, fried tomato prepared with the HOT concentrate IFPs with skins and seeds blended to 5% and 10% had an acceptable texture.
In the third trial the final results indicated that fried tomatoes sauce prepared using the IFPs obtained from tomato mixed with concentrations of 20% and 30% skins and seeds and subsequently concentrated were acceptable by the tasting panel, however, this was not true of the 50% concentration.

Conclusions and impact of the study
The production of fried tomatoes sauce using various IFPs in a HOT break concentrate caused no negative sensorial changes in the final product, and will be financially viable. These new IFPs also increase lycopene and fiber content. Furthermore, the elimination of added starch (with subsequent savings) and the reprocessing of current byproducts, has benefits for producer and consumer alike.
The International Society for Horticultural Science - in short ISHS – is a truly global network comprising over 53,000 individuals, universities, governments, institutions, libraries and commercial companies, thousands of whom joined as Individual Members, in addition to a substantial number of Institutional Members and some 50 Member Countries/Regions. It is a major source of up-to-date information on global horticultural research. ISHS aims to promote research in all branches of horticulture. It encourages the development of international co-operation, bringing together scientific and technical professionals to stimulate, facilitate and co-ordinate research and scientific activities on a global scale.

The Council, which meets every two years, is made up of delegates representing the interests of countries-regions, which have contributed a membership fee. Directors are elected by Council at the International Horticultural Congress which is held every fourth year. The Society’s policies are guided by the Board of Directors.

In addition to the Council and various sub-Committees, an Executive Committee manages the scientific program. It is composed of the Chairs of the Sections and Commissions. It is via these bodies that ISHS communicates with members who have specific research interests covering the full range of horticultural science.

Sections and Commissions establish Working Groups that focus on specialized subject areas. Working Groups have an elected Chair and membership comprised of eminent horticulturists/horticultural scientists. Currently there are more than 140 such Working Groups and others are formed when a need is identified.

The success of the ISHS, in relation to its effective communication and leadership of international co-operation, is largely through the 50 or more specialized symposia held annually. These are organised locally in a country, each with a convener, an organising committee, a scientific committee and an editorial board. Designed to be self-financing, these symposia normally concentrate on a technical subject – a crop or research area. Invited speakers present papers, research findings are debated, discussions held, visits arranged and the editor compiles a monograph published as a volume of Acta Horticulturae. These publications are available, at cost, to all ISHS members attending symposia and are archived in many academic/research libraries. The entire Acta Horticulturae library is available online and services the needs of thousands of researchers worldwide who use the www.actahort.org site.

The European Journal of Horticultural Science (eJHS) published by the ISHS in collaboration with the German Society of Horticultural Science (DGG) accepts original research articles and reviews on significant plant science discoveries and new or modified methodologies and technologies with a broad international and cross-disciplinary interest in the scope of global horticulture. The Journal focuses on applied and fundamental approaches to carry oriented research on aspects of the entire food value chain, ranging from breeding, production, processing, trading to retailing of horticultural crops and commodities. ISHS members benefit from discounted submission fees. eJHS is available in print + online Open Access.

The other avenue for regular communication is Chronica Horticulturae, the quarterly publication of ISHS. In addition to containing a calendar of events, announcements, news items and details of forthcoming events, Chronica reports on the activities of Sections, Commissions and Working Groups.

A major benefit of ISHS membership is the privilege of attending the International Horticultural Congress every four years at discounted rates. Congresses are attended by 3,000 or more delegates. They are carefully planned over many years to address all areas of horticultural science of interest to members. The Congress provides opportunities for individuals to present posters or make oral presentations of their current research work. Thus, information is shared with a wide audience. There are numerous social gatherings, sightseeing opportunities, and the chance to see local horticultural industries during specialized field trips.

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**Acta Horticulturae**

The full articles of research presented during the symposium will be published in a special issue of Acta Horticulturae, available at the end of 2016 directly from ISHS.

The proceedings of the 13th International Symposium on Processing Tomato can be purchased at:
http://www.ishs.org/ishs-book/1081