LYCOCARD®

ANNUAL REPORT 2007

SIXTH FRAMEWORK PROGRAMME

LYCOCARD®

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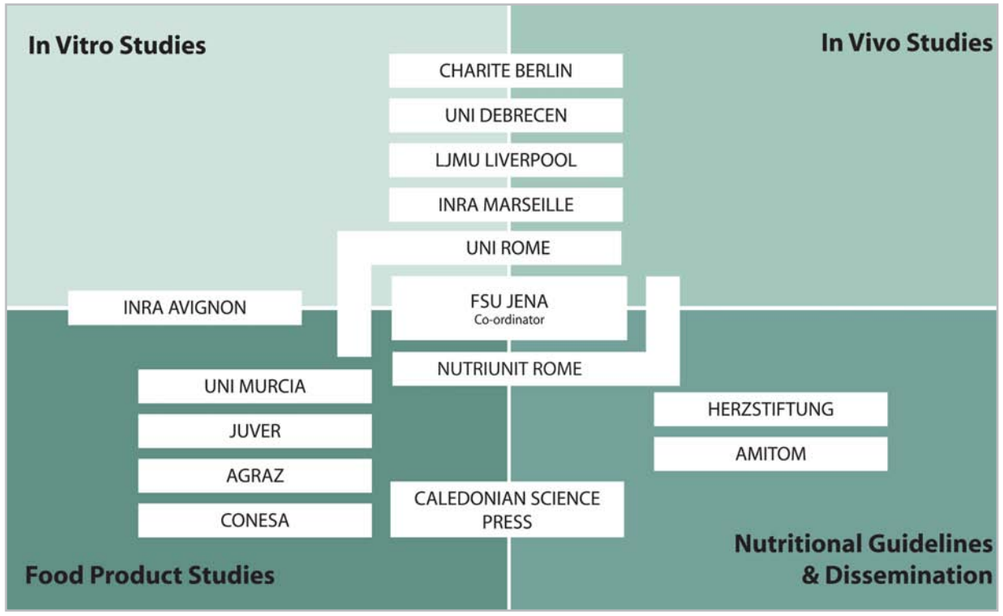

LYCOCARD's multidisciplinary, intersectoral consortium consists of 15 participants including scientists, technologists and patient organisations:

Friedrich Schiller University, Jena, Germany; CHARITÉ Berlin, Germany; INRA Avignon, France; University Debrecen, Hungary; Liverpool John Moores University, UK; University of Murcia, Spain; INRA Marseille, France; Catholic University Rome, Italy; Nutriunit Rome, Italy; Deutsche Herzstiftung, Germany; JUVER Alimentación, Spain; AMITOM, France; AGRAZ S. A., Spain; CONESA S.A.U., Spain; Caledonian Science Press Ltd, Scotland.

NOTE FROM THE CO-ORDINATOR

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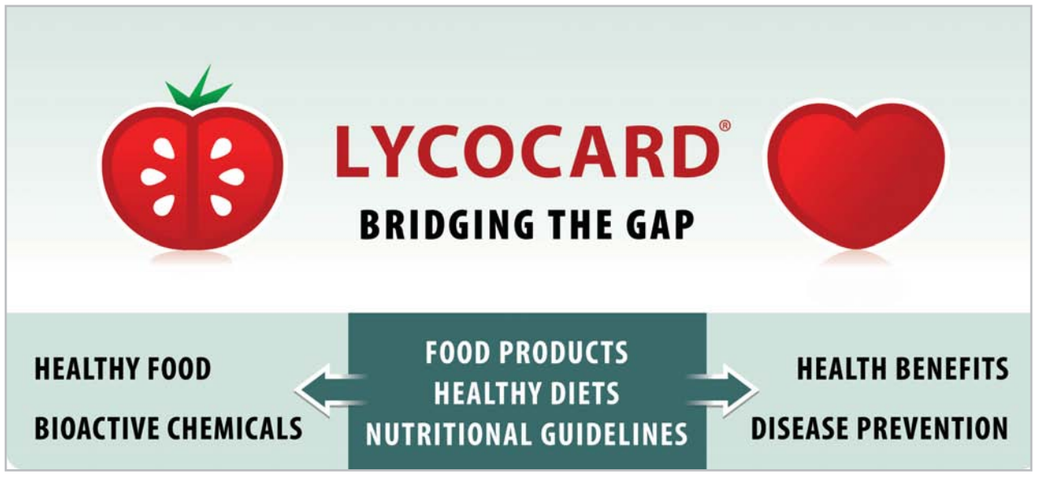
Cardiovascular diseases and cancer are the main mortality causes in Europe and all developed territories. Lycopene is a plant pigment found, amongst other things, in tomatoes, Europe's second-most important agricultural crop. Strong supportive data from several epidemiological studies suggest that lycopene may provide important protection against cardiovascular diseases and cancer. However, lycopene content of tomatoes and processed tomato products and lycopene's beneficial effects have not been sufficiently linked so far (Fig1).

LYCOCARD, an EU-funded Integrated Project (6th Research Framework Programme) that started in April 2006, is investigating the role of lycopene in reducing the risk of cardiovascular diseases, adopting a "total food chain" approach by addressing each link in a "farm to fork" procedure for future projects to increase the understanding of diet and health.

Specifically, LYCOCARD's multidisciplinary, intersectorial consortium (15 partners from 6 countries) of scientists, technologists, and patient organisations will clarify the following points: Effects of technological processing on lycopene, interactions between different food ingredients, molecular aspects of absorption and metabolism of lycopene, biological effects of lycopene isomers and lycopene metabolites. This information will lead to improved nutritional guidelines and healthy new foods based on tomatoes and other dietary sources containing lycopene. These novel dietary guidelines will help consumers to select specific diets which protect them against disease risk. LYCOCARD will therefore improve the health of European consumers and reduce the costs of health systems, while also significantly advancing the state-of-the-art. In addition, the position of the European food industry will be strengthened by increasing the demand for health-related tomato products and other newly developed healthful foods.

Research activities in the first year within a good working atmosphere have had a promising start and led to initial results presented hereafter.

Fig 1.



1st annual meeting, 21 – 23 March 2007, at the University of Murcia, Spain

LYCOCARD®

SIXTH FRAMEWORK PROGRAMME – INTEGRATED PROJECT "FOOD QUALITY AND SAFETY"

FULL TITLE: ROLE OF LYCOPENE FOR THE PREVENTION OF CARDIOVASCULAR DISEASES

Acronym: LYCOCARD - Contract No. 016213 - Start: 01 April 2006 - Website: www.lycocard.com

A balanced diet's positive effect on health is beyond dispute. However, it has yet to be discovered how specific food components benefit health. The general objectives of the LYCOCARD project are thus to examine how the biochemical and physiological processes of important food components and their interactions increase the beneficial effects on health. As correlative data suggest that an increased intake of lycopene may provide protection against cardiovascular diseases, the role of lycopene, its genetic, molecular, biochemical and physiological activity will be investigated within this project.

Research objectives are to investigate oxidative catabolism of lycopene and different aspects of lycopene bioavailability. Physiologically relevant isomers and metabolites will be tested on their protective antioxidant potential; the modulation of endothelial functions by these compounds is a further task. LYCOCARD will focus on the effects of lycopene and its derivatives on cell signalling pathways involved in cardiovascular health.

Two negative factors – cigarette smoke and cholesterol – will be investigated using *in vitro* and *ex vivo* models. All this research will constitute a significant advance beyond the current state of the art because it will move us away from simple correlations between particular foods and health benefits towards a detailed understanding of what specific aspects of these foods effect health benefits and how. Project objectives include development of new foods high in health-promoting compounds, to test the effectiveness of these foods in target populations and to develop health and dietary guidelines based on research outcome.

Dissemination objectives are the improvement of health and quality of life of European citizens and beyond, through better diet and improved nutritional guidelines; also to promote opportunities for SMEs and strengthen European competitiveness in the food industry. Training objectives are designed to contribute towards providing a highly trained workforce of biotechnologists and scientists, skilled in multi-disciplinary, pan-European cooperation.

STATE-OF-THE-ART

Several studies reveal the main risk factors for cardiovascular diseases: cigarette smoking and serum (LDL) cholesterol levels. There is a scientific consensus that atherosclerosis represents a state of increased oxidative stress characterised by lipid and protein oxidation in the vascular wall. Epidemiological studies support the hypothesis that carotenoids (including lycopene) may protect cells from oxidation. Tomatoes' and tomato products' protective effects on health have been examined for many years, but the scientific reasons for their beneficial effects as well as lycopene's interaction with other tomato components are not entirely clear.

This brief review has shown that there is plenty of information about the development of cardiovascular diseases as well as good evidence that certain foods – such as tomatoes – are healthy. However, these two aspects are not sufficiently linked because research has lacked a "total food chain" approach. LYCOCARD will bridge this gap by researching the effects of technological processes on lycopene, interactions between different food ingredients, major molecular aspects of absorption and metabolism of lycopene, and biological effects of lycopene isomers and lycopene metabolites. This information will lead to improved nutritional guidelines and healthy new foods. LYCOCARD will serve also as an example of how collaborative research and application can take up the "total food chain" and "farm to fork" approaches for future projects to increase the understanding of diet and health.

EXPECTED END RESULTS

The expected end results of LYCOCARD are to understand the biochemical and physiological activity of lycopene and translate this understanding into development of new foods and dietary guidelines that improve the health and quality of life of European citizens.

TRILLION EURO FOOD SECTOR PROVIDES CAUSE AND CURE

Tomato+Health Newswire July 10th 2007

Food and drink is the largest industrial sector in Europe. Earlier this year, the Confederation of Food and Drink Industries of the European Union (CIAA) published the following key figures about the scale of the industry:

3.8m EU citizens work in food and drink

Generated sales are worth close to a trillion euros

Food industry uses 70% of EU agricultural raw materials

Sector comprises 99% SME, defined as fewer than 250 staff

CIAA president, Jean Martin, voices the industry's response to the current public health scandal of the epidemic rise in cardiovascular diseases, chronic obesity and diabetes across Europe today:
"Europe's food and drink industry is committed to being part of the solution, as the numerous actions we have undertaken demonstrate."

"For years, we have been responding to changing consumer demands with increased choice, 'lighter' products and smaller portion sizes... We have also been doing things that are less obvious: extensive research, public education, promotion of healthy lifestyles, partnerships with doctors, teachers, schools, public health officials and non-governmental organisations, and the voluntary restrictions on advertising and marketing to children."

Broadcasting generic food and health facts based on proven, independent scientific research is now seen as the only meaningful way forward. However, as consumer choice is today driven by the increasing need to save time preparing food, the outlook for public health trends is unlikely to change easily.

Despite the presence of some very strong brands and many healthful products, the simple fact is that major brand owners have yet to realise that branded health claims have lost almost all credibility as a better educated public now actively seek the truth about why foods work, and purchase accordingly. It is the small specialist suppliers who have begun to innovate and react to consumer demands, developing niche-market health products and taking a noticeable slice of market share away from the sleeping giants.

The second largest agricultural sector in Europe is tomato for both fresh, and more importantly, processing markets. Away from the CIAA, a new research project LYCOCARD, publicly funded by the EU, will run for 5 years at a cost of 5.2M€ Its focus is to determine the precise health benefits of lycopene and other potent nutrients found in tomato and processed tomato products, in preventing or treating cardiovascular diseases. This is part of a growing trend towards research that clearly establishes the scientific reasons for convincing consumers how and why certain foods can benefit their health.

"The project's findings will lead to novel dietary guidelines which will help consumers to select specific diets to prevent and minimise their disease risk" explains LYCOCARD project co-ordinator Dr. Volker Böhm of the University of Jena.

"LYCOCARD will therefore improve the health of consumers in Europe (and worldwide), helping to reduce the immense and ever growing costs of health care systems, simultaneously and significantly advancing the state of the art. In addition, the position of the European food industry will be strengthened by increasing the demand for health-related tomato products, and hopefully the desire to foster healthier dietary habits."

Research in this area is not new. LYCOCARD follows up where many studies have left off. In January of this year, a science reference book "Tomatoes, Lycopene & Human Health" was published with a chapter that looks at the previous and current scientific findings in this area. Dr. Tiina Rissanen, working in the Research Institute of Public Health at the University of Kuopio, Finland, found concrete results in the multi-centre European Study of Antioxidants, Myocardial Infarction and Cancer of the Breast (EURAMIC) (a). This project examined the association between the antioxidant concentration in fat tissue and the incidence of myocardial infarction in 10 countries.

"The study found that men with the highest concentrations of lycopene in their adipose tissue had a 48% reduction in the risk of developing CVD when compared with those men with the lowest lycopene levels. In a part of the same EURAMIC study from the Malaga centre (b), there was a 60% lower risk of myocardial infarction among those participants in the highest quintile (fifth) of adipose tissue lycopene concentration as compared with the participants in the lowest quintile."(c)

Though these results seem to be very positive, a number of other studies have been less conclusive and so the urgent need for well-funded and intensive research is essential. Hence, LYCOCARD will hopefully establish the precise nature and reasons why the once unnoticed and humble tomato may be transformed in the hearts and minds of the public into a superfood.

As uncertainty looms while EU (processing) tomato-farming subsidies are de-coupled and phased out, the competitiveness of the European tomato industry may come to depend more and more on its ability to adapt and innovate, design and provide consumers with new health-oriented product choices. One area of LYCOCARD is collaboration between the scientists and the 4 SME industrial partners working to understand how this can be made a reality over the next 4 years.
As LYCOCARD scientists meet in Paris in July to go public with their first results, industrial and public attention will focus on how this research may change consumers feelings towards this simple food commodity and re-evaluate its true worth both for future public health issues and the new business opportunities which will rise from the unbending and conservative practices of the past.

Even the simplest of public health nutrition and educational initiatives can produce the most dramatic results. The confidence that comes with an informed view of food and nutrition can last a lifetime and enrich it as well as extend it. Public awareness of the value of fruit and vegetables as part of a healthy diet may be greater than their adoption as mainstream dietary staples, but it is a start.

Footnotes

(a) Kohlmeier L, Kark JD, Gomez-Gracia E, Martin BC, Steck SE, Kardinaal AF, Ringstad J, Thamm M, Masaev V, Riemersma R, Martin-Moreno JM, Huttunen JK and Kok FJ. Lycopene and myocardial infarction risk in the EURAMIC Study. American Journal of Epidemiology 1997; 146:618-626.

(b) Gomez-Aracena J, Sloots L, Garcia-Rodriguez A, Van't Veer P., Gomez-Gracia E, Garcia-Alcantara A, Martin-Moreno JM, Kok FJ and Fernadez-Crehuet NJ. Antioxidants in adipose tissue and myocardial infarction in a Mediterranean area. The EURAMIC study in Malaga. Nutrition, Metabolism and Cardiovascular Diseases 7 (1997) 376-382

(c) Rissanen T, Lycopene and Cardiovascular Disease, chapter in Rao V (ed), "Tomatoes, Lycopene & Human Health, preventing chronic diseases". Caledonian Science Press Ltd. 2006, ISBN 0-9553565-0-4

LYCOPENE, ITS METABOLITES AND ITS OXIDATIVE/DEGRADATIVE PRODUCTS: BIOLOGICAL ACTIVITIES IN *IN VITRO* MODELS

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Dietary intake of tomato and tomato products containing lycopene have been shown in numerous studies to be associated with decreased risk of cardiovascular diseases (CVD). However, little is known about the mechanisms of action by which lycopene exerts its beneficial effects and the role of its metabolites. LYCOCARD is focussing its attention on understanding the molecular, biochemical and physiological functions of lycopene, and its related compounds, in protecting the human body against CVD. In particular, *the in vitro* section of the project, by using several *in vitro* models (including cellular and acellular systems), is investigating the following aspects of lycopene:

- Isolation, characterisation and biological activity of lycopene isomers and oxidation products. Recent data suggest that the biological functions of lycopene are not due to the molecule itself, but are due to the formation of lycopene metabolites. To this purpose, lycopene (Z)-isomers and lycopene oxidation products, generated by organic synthesis or formed *in vitro* by the exposition of lycopene to chemical oxidants, will be adequately isolated and characterised in terms of chemical properties. Moreover, their biological functions (antioxidant activity, ability to modulate gene expression) will be tested *in vitro*.

- Role of membrane transporters of lipids (SR-BI, CD-36, NPC1L1…) in the intestinal absorption of lycopene. It has been shown that some carotenoids, such as lutein and ß-carotene, are incorporated into the intestinal cell (enterocyte) by specific membrane transporters. It is hypothesised that such a mechanism occurs also for lycopene. To this purpose, intestinal cells (Caco-2 clone TC7), over-expressing or lacking candidate lycopene transporters (by transfection or siRNA), will be studied for their ability to absorb lycopene.

- Role of lycopene against the oxidative stress induced by cigarette smoke and cholesterol/oxysterols, two of the most important risk factors responsible for cardiovascular diseases. It has been reported that cigarette smoke condensate (tar), as well as some oxidation products of cholesterol present in the atheromasic plaque, act as strong cellular stressors by increasing the production of reactive oxygen species and by altering redox-sensitive signalling pathways. The efficiency of lycopene in limiting oxidative stress, as well as the formation of lycopene oxidation products formed by the interactions between cigarette smoke condensate and cholesterol/oxysterols will be evaluated in vascular cells.

- Role of lycopene in modulating cell signalling pathways involved in endothelial functions and in the regulation of cell proliferation, differentiation and apoptosis of vascular cells and adipocytes. Recent data suggest that lycopene may modulate gene expression through a mechanism unrelated to its redox properties. Therefore, the regulation of gene expression by lycopene and its metabolites will be investigated.

All the studies take into account several problems concerning lycopene administration to *in vitro* models, including the solubility of the carotenoid and its derivatives *in vitro*, the comparison with doses achieved *in vivo* by dietary means and the possible interactions with other antioxidants.

IN VITRO STUDIES HAVE BEEN ORGANISED INTO THE FOLLOWING WORK PACKAGES (WP):

WP 1. Fractionation and isolation of lycopene (Z)-isomers *(Dr. V. Böhm, Jena University, Germany)*.

WP 2. Isolation of lycopene metabolites from acellular models and/or by organic synthesis *(Dr. C. Caris-Veyrat, INRA Avignon, France)*.

WP 3. Determination of the antioxidant activity of (Z)-isomers and metabolites of lycopene in different model systems (*Dr. V. Böhm, Jena University, Germany)*.

WP 4. Transactivation of nuclear hormone receptor pathways by lycopene, lycopene (Z)-isomers and lycopene metabolites *(Dr. R. Rühl, Debrecen University, Hungary)*.

WP 5. Evaluation of nuclear receptors target gene expression in the presence of lycopene (Z)-isomers and metabolites *(Dr. R. Rühl, Debrecen University, Hungary)*.

WP 6. Study of the involvement of transporters for lycopene absorption *(Dr. P. Borel, INRA/INSERM/Marseille University, France)*

WP 7. Effects of lycopene, lycopene (Z)-isomers and lycopene metabolites on adipocyte differentiation *(Dr. P. Borel, INRA/INSERM/Marseille University, France)*

WP 8. Establishment of methods to deliver lycopene, its (Z)-isomers and its metabolites alone and in combination with cigarette smoke condensate (tar), cholesterol and oxidised LDL into cultured cells *(Dr. V. Stangl, Charité Berlin, Germany)*.

WP 9. Study of the effects of lycopene on the oxidative status of vascular cells exposed to tar or to cholesterol/oxysterols/oxidised LDL *(Dr. P. Palozza, Catholic University of Rome, Italy)*.

WP 10. Study of the effects of lycopene on cell growth and differentiation of vascular cells exposed to tar or to cholesterol/oxysterols *(Dr. P. Palozza, Catholic University of Rome, Italy)*.

WP 11. Characterisation of intracellular lycopene metabolites and oxidation products formed by the interaction of lycopene with cigarette smoke condensate or cholesterol *(Dr. P. Palozza, Catholic University of Rome, Italy)*.

WP 12. Comparative studies of the effects of lycopene, extracts from fresh tomatoes and lyophilised tomatoes, lycopene (Z)-isomers and other tomato carotenoids (ß-carotene and phytofluene) on redox status and cell growth of vascular cells exposed to cigarette smoke condensate and cholesterol/oxysterols *(Dr. P. Palozza, Catholic University of Rome, Italy)*.

WP 13. Characterisation of oxidation products of lycopene and apolipoprotein B 100 in oxidized LDL *(Dr. G. Lowe, Liverpool University, UK)*.

WP 14. Evaluation of lycopene effects on endothelial function *(Dr. V. Stangl, Charité Berlin, Germany)*.

Such studies should provide more insight into the molecular mechanisms underlying the bioactivities of lycopene and they should help to determine which dose of lycopene (or its metabolites) combined with other antioxidants provides optimal protection while not increasing the risk of formation of undesirable metabolic by-products (especially in smokers and hypercholesterolemic subjects).

During the first year, fractionation and isolation of lycopene (Z)-isomers and lycopene metabolites as well as methods to determine the lipophilic antioxidant activity were optimised. Several models were established to test the transactivation of nuclear hormone receptors pathways by lycopene isomers and metabolites. For these experiments cell models without carotenoid metabolism as well as those with carotenoid metabolising enzymes will be used. A target gene expression system was also established. First preliminary results are available regarding the involvement of intestinal membrane transporters in lycopene absorption. A variety of experiments were done to find a reproducible method to deliver lycopene to different types of cells. In the end, two procedures were set up. Protocols were established to investigate the effects of lycopene on the oxidative status of vascular cells. Endothelial function, as affected by lycopene, was investigated by using precontracted rat aortic rings. (all-E)-Lycopene showed some promising results. All these experiments will be continued with different (Z)-isomers and metabolites of lycopene.

IN VIVO INVESTIGATIONS ON BIOLOGICAL ACTIVITIES OF LYCOPENE BIOLOGICAL ACTIVITIES IN *IN VITRO* MODELS

PATRICK BOREL, PhD
2006-2007 Project Pillar Leader of the *in vivo* studies within LYCOCARD

INSERM, U476 « Nutrition Humaine et Lipides » / INRA, UMR1260 / Univ Méditerranée Aix-Marseille 2, Faculté de Médecine / IPHM-IFR 125 - Marseille, France

There are many specifics regarding bioavailability, metabolism, and the molecular mechanisms involved in lycopene's biological activities that are still not fully understood. Lycocard's *in vivo* studies consist of both animal and human trials aiming to answer the following main questions:

- Do genetic polymorphisms in putative intestinal transporters of lycopene affect lycopene absorption efficiency? It has recently been shown that some carotenoids (lutein and ß-carotene) are taken up by the intestinal cells through membrane transporters (SR-BI, CD36). The role of these transporters, and of other candidate transporters, on lycopene absorption is currently studied by using an *in vitro* model of intestinal cells (see chapter on *in vitro* studies). The hypothesis is that different variants in the genes coding for these transporters may lead to transporters with differing abilities for the transfer of lycopene. Therefore, subjects bearing different variants may have different absorption capacities.

- Does absorption efficiency depend on lycopene cis-trans (Z/E) isomerisation? Lycopene is mainly found as its (all-E)-isomer in foods. Conversely, it is mainly recovered as (Z)-isomers in human blood and tissues. The reason for this paradox is not fully understood but one hypothesis is that (Z)-isomers are better absorbed than all-trans lycopene. This will be studied by using stable isotopes of lycopene.

- What are the main lycopene metabolites produced in the body? Lycopene is assumed to exert its beneficial effects by its antioxidant properties. However, recent results suggest that it can also modulate gene expression in several tissues. Furthermore, it is strongly suspected that it is not the lycopene molecule *per se* which interacts with transcription factors, but rather its metabolites. A big challenge in this field is therefore to identify these metabolites in human tissues.

- What is the concentration of lycopene and its metabolites in tissues? As stated above, lycopene metabolites may be responsible for some biological effects of lycopene. However, scarce data are available on their concentration in different human tissues. These data are essential for studying the biological effects of these molecules at physiological concentrations.

- What is the role of lycopene on gene activation? It is suspected that lycopene metabolites, probably apo-lycopenoic acids, can modulate gene expression. However, which genes in which tissues and to what extent? Studies with transgenic mice and microarrays performed in LYCOCARD will boost our knowledge of this important mechanism of action of lycopene.

- What is the effect of lycopene on redox status? The role of antioxidant microconstituents (mainly carotenoids, polyphenols and vitamins E and C) on redox status is still the subject of controversy. It was assumed that an antioxidant effect of these molecules is the main mechanism by which they exert their beneficial effect on diseases where free radicals are implicated. However, numerous studies have failed to demonstrate this under physiological conditions (e.g. LDL physiologically enriched with carotenoids). The methods used to assess this antioxidant effect have been criticised. It is therefore important to re-assess the antioxidant effect of lycopene by using cutting edge methodologies.

- Does lycopene improve endothelial function? One of the biological targets where lycopene is suspected to exert its protective effects on arteriosclerosis is the endothelium of blood vessels. It is therefore sound to study its role on endothelial function.

IN VIVO STUDIES HAVE BEEN ORGANISED INTO THE FOLLOWING WORK PACKAGES (WP) :

WP 15.	Determination of nuclear receptor activation by lycopene, lycopene (Z)-isomers/metabolites and tomato preparations in transgenic animals (*Dr. R. Rühl, Debrecen University, Hungary*).
WP 16.	Analysis of the redox status of mononuclear cells isolated from chronic smokers and hypercholesterolemic patients before and after supplementation of a tomato-rich diet (*Dr. P. Palozza, Catholic University of Rome, Italy*).
WP 17.	Effect of polymorphisms in intestinal lycopene transporter(s) on lycopene bioavailability (*Dr. P. Borel, INRA/INSERM/Marseille University, France*).
WP 18.	Evaluation of oxidative stress and lipid status in human plasma: influence of smoke exposure and lycopene supplementation (*Dr. G. Lowe, Liverpool University, UK*).
WP 19.	Study of lycopene isomerisation in human plasma by isotopically labelled lycopene (*Dr. V. Böhm, Jena University, Germany*).
WP 20 -21.	Evaluation of arteriosclerosis prevention by lycopene in an animal model and in humans (*Dr. V. Stangl, Charité Berlin, Germany*).
WP 22 -23.	*In vivo* effect of diets enriched with traditional and newly developed tomato products on obese and normal weight subjects (*Dr. A. Mordente, Nutriunit Rome, Italy*).

During the first year, the main focus has been on preparation for studies to be started later. A mice model was established to study the *in vivo* metabolism of lycopene. Tomatoes containing isotopically labelled lycopene were grown to be used in human intervention trials investigating the in vivo isomerisation process of lycopene. A preliminary human trial was started measuring the endothelial function after intervention with a tomato product. Recruitment of subjects was nearly finished for another human intervention trial. Anthropometric and clinical baseline values were determined for all subjects recruited.

LYCOPENE AND OTHER ANTIOXIDANTS IN TOMATO AND TOMATO PRODUCTS

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Tomato and tomato products are the main dietary source of lycopene in the occidental diet. Although a relationship has been suggested between the beneficial effects of tomatoes on human health and lycopene intake, there is lack of detailed information about the accessibility and bioavailability of lycopene. LYCOCARD's food product studies include the study of tomato and tomato products in greater detail, the objective being to obtain information all along the food chain from field to table. These trials will allow the following questions to be answered:

- Which main factors determine the lycopene content and other bioactive compounds such as phenolic compounds, vitamin C and folates? The bioactive compounds can be determined by several factors depending on the tomato and on the agronomical conditions. Factors such as variety or cultivar, maturity index and temperature determine the content of these compounds.

- How can tomatoes be handled in the field and post harvest to improve the content of lycopene and other bioactive compounds? The on-vine and off-vine maturation can determine the total content of lycopene and other bioactive compounds. The temperature of storage and the application of UV light in a post-harvest treatment can also determine the content of antioxidants and especially the isomerisation of lycopene.

- What is the contribution of the different antioxidant compounds to the antioxidant activity of tomatoes, considering the lipophilic and hydrophilic activity? The hydrophilic and lipophilic antioxidant activity of tomatoes depends on the major antioxidant compounds present in the extract. Lycopene is the major lipophilic compound, whereas vitamin C is the major hydrophilic antioxidant. Phenolic compounds and folates exhibit a hydrophilic antioxidant activity.

- Can tomato prevent the oxidation of macromolecules (lipid, protein and DNA) using an *in vitro* model? The consumption of tomatoes and tomato products increases the uptake of the antioxidant compounds, which carry out an antioxidant effect in the human body, preventing oxidative damage in macromolecules which is related to the genesis of several chronic diseases.

- How does industrial processing and storage affect the total content of lycopene as well as antioxidant compounds and lycopene isomerisation? Tomato products possess the highest amount of lycopene and other antioxidant compounds since industrial processing concentrates tomatoes by a reduction of water content. It is also generally accepted that bioavailability of lycopene in tomato products is higher than in raw tomato due to industrial processing which leads to a breakdown of cellular structure and an increase in the isomerisation of lycopene.

- What happens during gastric and intestinal digestion of tomatoes and tomato products? The accessibility of lycopene and other antioxidant compounds will be determined using an *in vitro* digestion model, aiming to evaluate the lycopene isomerisation. The bioavailability will also be evaluated with an in vitro model using cell culture.

- Could a functional tomato product with a tested effect in the prevention of cardiovascular disease be developed? With all the scientific information from the *in vitro, in vivo* and food product studies, food scientists and the food industry aim to design and develop a tomato product with added health benefit to prevent the incidence of cardiovascular disease in European citizens.

FOOD PRODUCTS STUDIES HAVE BEEN ORGANISED INTO THE FOLLOWING WORK PACKAGES (WP) :

WP 24. Analysis of bioactive compounds in tomatoes (*Dr. M. J. Periago, Uni Murcia, Spain*, **and** *J. Fernández, AGRAZ, Spain*).

WP 25. Evaluation of the antioxidant activity of tomatoes and tomato-based products (*Dr. P. Palozza, Catholic University of Rome, Italy, Dr. M. J. Periago, Uni Murcia, Spain, and J. Fernández, AGRAZ, Spain*).

WP 26. Search for in vivo metabolites of lycopene and human intervention studies with newly developed tomato products. (*Dr. V. Böhm, Jena University, Germany).*

WP 27. Accessibility and availability of bioactive compounds (*Dr. C. Caris-Veyrat, INRA Avignon, France, and Dr. M. J. Periago, Uni Murcia, Spain*).

WP 28-29. Evaluation of tomato components following processing/Evaluation of lycopene stability during storage. The effect of tomato product processing and storage on the content of lycopene and other bioactive compounds is being evaluated between Uni Murcia, Spain and two tomato industry processors. *F. Hermosilla, JUVER Alimentación S.L.U., Spain* and *R. Pérez, CONESA S.A., Spain*.

WP 30. Development of a tomato-based product for nutritional improvement (*Dr. M. J. Periago, Uni Murcia, Spain, F. Hermosilla, JUVER Alimentación S.L.U., Spain, R. Pérez, CONESA S.A., Spain and D. Cameron, Caledonian Science Press, Inverness*).

The first year started with a training course to allow all partners involved in this project pillar to use the same analytical procedures. Afterwards several tomato varieties were analysed on the contents of carotenoids, total phenolics, vitamin C and folate. First experiments evaluated the antiproliferative effect of tomato extracts in cell cultures. In addition, the effects of processing tomatoes to different tomato products on the bioactive ingredients were investigated.

DISSEMINATION: SPREADING THE WORD ABOUT LYCOCARD

SOPHIE COLVINE
2006-2007 Project Pillar Leader of the dissemination packages within LYCOCARD

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Dissemination of the existence of the project, its aims, purpose and results is an integral part of the LYCOCARD project and since the start, major efforts have been made to make sure the scientific community, tomato processing industry, patient care organisations and the general public, as applicable, are kept informed through a broad range of dissemination activities starting with the project website and including conferences, publications and press releases sent via all project partners.

In the first year of the project, the main actions have been:
The creation of the project website, www.lycocard.com. The Extranet section gives information on the state-of-the-art and the consortium. Project results will be added as the programme progresses. The Intranet (member area) section provides consortium members with a way to exchange information confidentially and securely.
The publication of a an A3 project presentation brochure in May 2006: this brochure has been widely distributed by consortium members and its contents translated into several languages which are available as downloadable PDF files on the website.
The creation of **presentation posters** in several languages**,** **banners** and a **PowerPoint presentation** which has been used by project partners to present the project at scientific and industry events.
Several consortium members have produced **press releases**, published **articles** in their internal publications, on their websites, and organised events and/or press conferences where they have presented the consortium. These have had a major impact and been widely distributed resulting in a number of articles in magazines and on websites and several television and radio interviews.

With funding raised by LYCOCARD partner 12, AMITOM, partner 15, Caledonian Science Press, created, designed and published a new consumer magazine title (issue 1, 16-page full colour in French) entitled "Tomate & Santé" containing a 2-page feature article on LYCOCARD and a 1-page interview with Catherine Caris-Veyrat (from INRA). Print run was 5000 copies, this magazine was used to accompany a press conference during the SIAL food exhibition in Paris on 25 October 2006 in which these 3 partners participated. The magazine has been sent widely to the scientific, medical and industrial communities in France and beyond to the media across France and Europe. As a media kit it provoked many journalists to publish articles in the months following SIAL.

The book ***Tomatoes, Lycopene & Human Health, preventing chronic diseases*** (published October 2006 by LYCOCARD consortium partner 15 Caledonian Science Press) featured a chapter on LYCOCARD written by the project coordinator Dr. Volker Böhm. This first ever science reference book to cover the spectrum of health topics relating to lycopene, tomato and tomato products and human health issues was edited by a team of internationally recognised scientists from 12 countries. The initial print run of 5000 copies has been sold all over the world.

FUTURE EVENTS

Over the next 12 months, there will be many new ways to learn more about the project; also the chance to meet with LYCOCARD scientists at the following events:

European Nutrition Conference, Paris (France), 10-13 July 2007:
www.fens2007.org

The LYCOCARD Annual Report 2007 brochure will be published in time to be distributed at this conference.

During this event, the first results and ongoing studies of the LYCOCARD project will be presented during a special session entitled "LYCOCARD: Investigating the role of lycopene in the prevention of cardiovascular diseases". The session will take place on July 11, 2007 from 18:00 to 19:30.

Tomato Day, Parma (Italy) 18 October 2007

The first results and future research of the LYCOCARD project, with special emphasis on the collaboration between the science and the 4 SME industrial partners will be presented in a conference specially targeting the tomato processing industry held during the Tomato Day conference at the Cibus Tec exhibition in Parma on 18 October 2007 (10 am to 1 pm). **www.fiereparma.it**

LYCOCARD scientists will also present their work at:

FAV HEALTH 2007 - 2nd International Symposium on Human Health Effects of Fruit and Vegetables, Houston (Texas), 9-13 October 2007 **http://favhealth2007.tamu.edu/**

8th World Processing Tomato Congress, Toronto (Canada), 8-11 June 2008
www.worldtomatocongress.com

15th International Symposium on Carotenoids, Okinawa (Japan), 22-27 June 2008
www.carotenoidsociety.org

Tomato+Health®

A new online dissemination platform (www.TomatoAndHealth.com) has been designed and developed by partner 15, Caledonian Science Press. This is an affiliate website to the LYCOCARD project. It has been designed as a multi-audience, online health and nutrition magazine following on from the intial designs for the printed edition of "Tomate et Santé" in October 2006. Funded externally from the project as an additional "out of scope" dissemination activity, the site has already captured tomato industry interest from Europe and globally. The English language edition of the site will launch later in the summer. For more information send to: lovehearts@tomatoandhealth.com

For more information and for regular updates about the LYCOCARD project, please visit:
www.lycocard.com

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Tomato+Health®

Tomato+Health is a brand new, online public health & nutrition magazine. An open access web resource, free to all, servicing the demand for impartial, unbiased dietary advice. Filled with nourishing information and the very latest science for health-professionals and patient groups, loads of fun food recipes for kids plus games and puzzles, tasty Mediterranean menus, cooking tricks, mp3 recipes and the super fast Tomato TV cooking show.

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