HACETTEPE UNIVERSITY

FOOD RESEARCH CENTER

Effects of nanoencapsulated ingredients on food quality

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Hacettepe University

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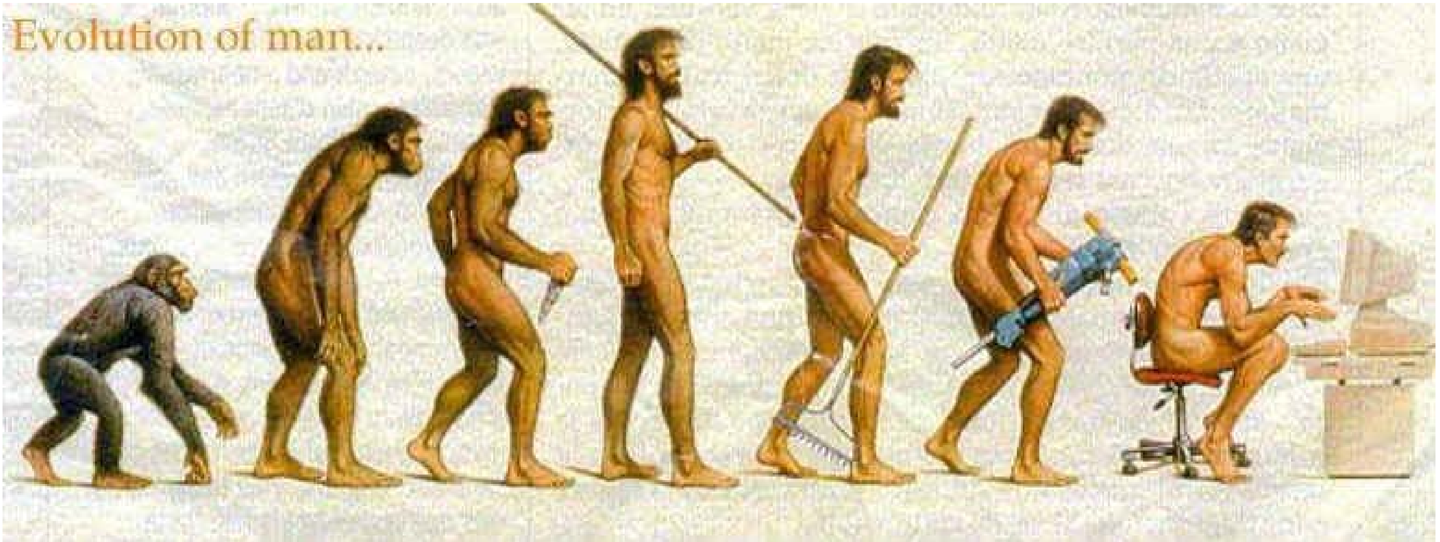
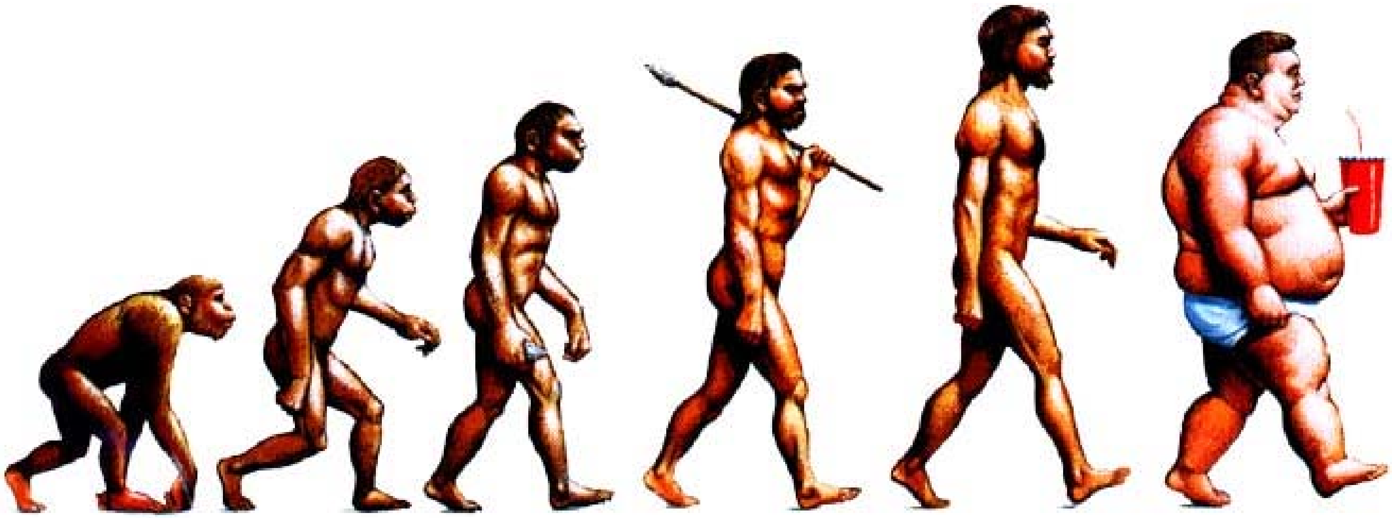
Are we evolving in the right direction?





Food and Health

- **Nanotechnology**
- Encapsulation of "**bioactive compounds**"
- To design new generations of "**functional foods**"
- To Improve health, well-being and longevity

To respond consumer concerns and interests; to stimulate competitiveness, job creation and economic growth; to deal proactively with the need to enhance sustainability, etc …

European Technology Platform Food for Life

nanoFOODS

SEVENTH FRAMEWORK PROGRAMME

OBJECTIVE

to develop and validate the efficacy of a new generation of healthy foods based on nanocapsules technology.

The nanofood revolution

Nanocapsule technology represents an exciting breakthrough in food science. NANOFOODS, led by Professor Vincenzo Fogliano, is exploring the benefits and applications of this emerging discipline

What are NANOFOODS' overall aims and objectives, and how do you plan to implement them?

The overall objective of the project is to produce and functional validate the function of conceptually new healthy foods based on nanocapsules technology. Tailored nanocapsules are able to deliver functional components such as omega-3 fatty acid and silymarin, which is proven to have anti-cancer effects against human prostate adenocarcinoma cells, into the lower gut will be designed and produced. These new ingredients have been incorporated into different foods by the food SMEs joining the project who will implement the scientific findings of the project developing new functional products.

Will these nanocapsules be incorporated as bioactive ingredients into dry pasta, bread products and nut cream, and be used for bioavailability and efficacy?

Yes, we selected these items because they are representative of the different kind of food matrices rich in starch or lipids. Yet all undergo intense thermal treatment during processing adopting condition that can lead to the degradation of bioactive compounds. The interaction with the food components deeply affects the bioavailability of active compounds in conventional functional foods. Through the use of encapsulated functional ingredients, it is expected that the behaviour during gastro-intestinal digestion, and consequently the bioavailability, will be quite independent from the type of foods. Bioavailability studies on healthy volunteers will be carried out to assess this point.

Another important consideration that addressed the selection of the foods is that pasta and bread represent staple foods in many countries. Therefore, the incorporation of bioactive compounds in these products could potentially lead to a significant rise in daily intake of the beneficial bioactive compounds by the general population.

How was the selection of fatty acid and phenolic compounds done considering the need to set up the technology of nanocapsule preparation for the two main classes of bioactive molecules i.e. lipophilic and hydrophilic compounds?

There were three levels of selection for the core bioactive compounds. Firstly the expected biological activity: in this case as we were interested in the anti-inflammatory actions so compounds which are known for this activity were selected. Secondly, we decided to focus on one hydrophilic and one lipophilic compound to set up the optimal coating procedure for the two opposite situations. Thirdly the sensorial acceptability in the final products: the goal of the overall activities was to develop products which do not have sensory differences from their conventional alternatives.

The research centres participating in the consortium have a great experience in nanotechnology, functional foods and food chemistry while one of the SME of the consortium is specializes in development and production of encapsulated products. How do you view collaboration and what part has it played in your project?

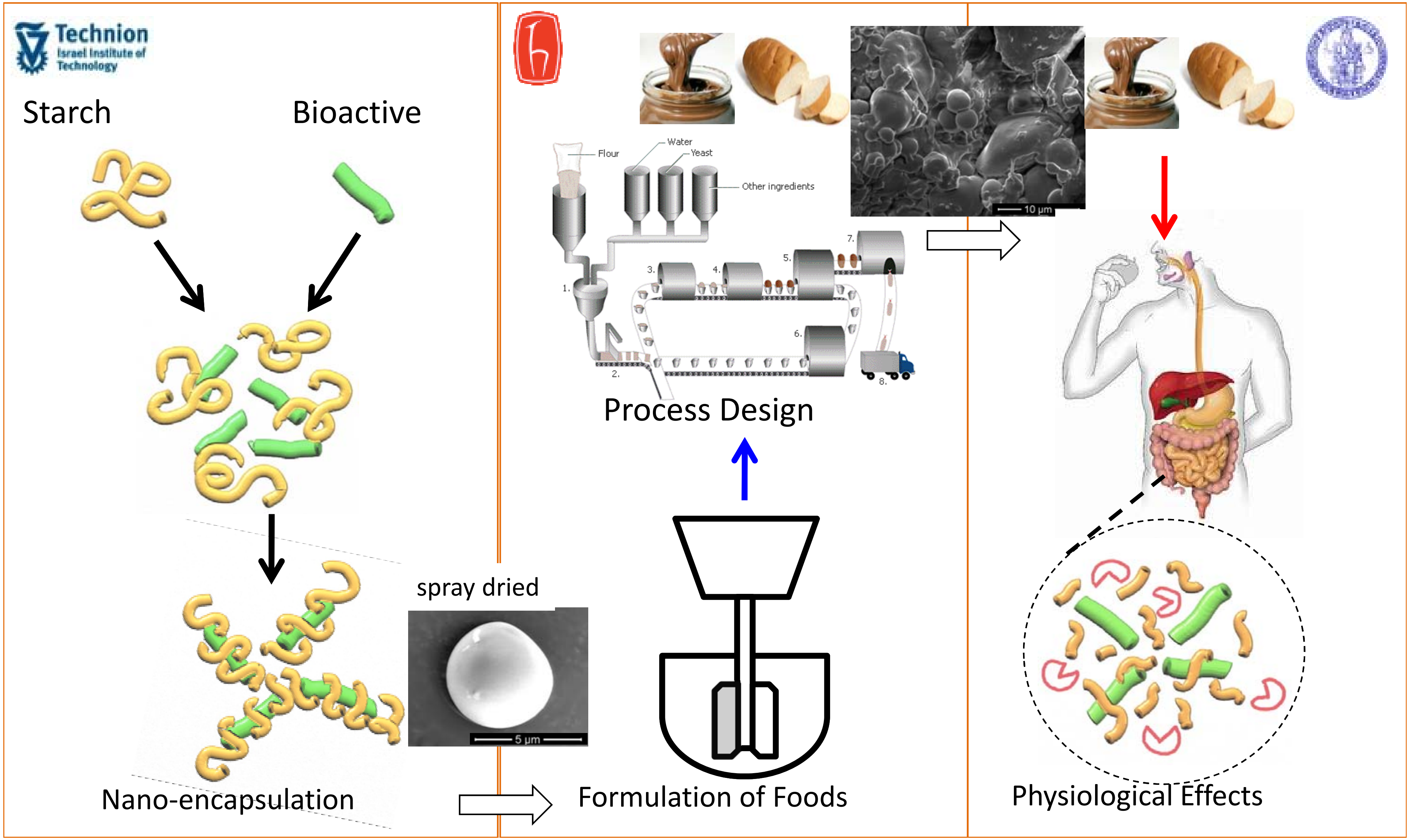
The collaboration between the NANOFOODS research partners began many years ago in the framework of COST action 927 and it will continue after project completion. The success of our research activity is adopting a problem solving approach that is highly appreciated by food companies, many of whom have been working with us for some time. In this case, to strengthen the collaboration among RTDs, performers and SMEs, three young researchers have been selected at the very beginning of the project to carry out the work at the boundary between research centres and SMEs. These people were able to combine the needs of the companies with the rigorous scientific parameters necessary to perform high quality scientific research.

nanoFOODS CONTENT

- To develop functional foods incorporated with bioactive compounds

- Prototype foods and bioactives concerned
  - **Bread**
    - **Omega fatty acids**
    - **Silymarins**
  - Hazelnut Cream
    - Cocoa Phenolics
  - Pasta
    - Omega fatty acids
    - Silymarins

nanoFOODS OVERVIEW



WHY ENCAPSULATION?

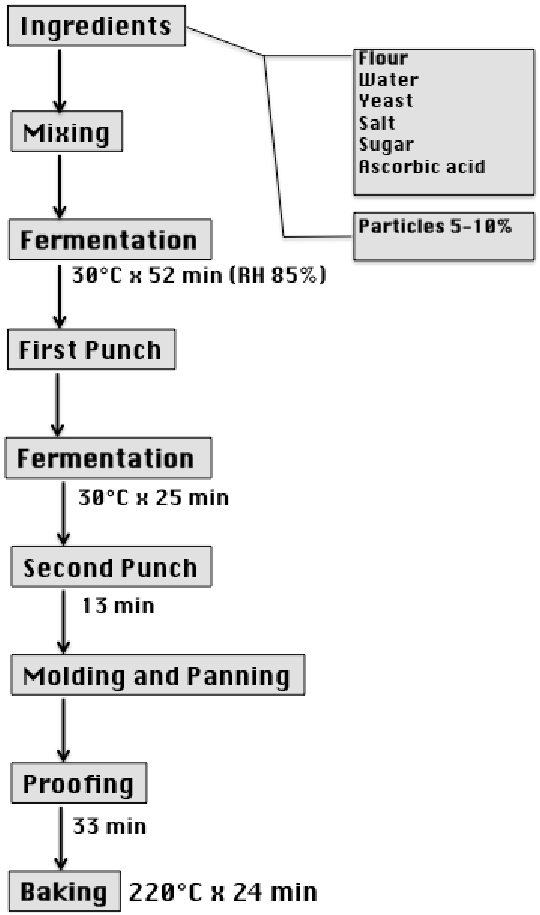
- Controlled release of bioactive compounds (targeting)
- Masking sensory properties (taste, smell, color) of bioactive compounds
- Protecting bioactive compounds against matrix/process induced chemical changes

BREAD MAKING

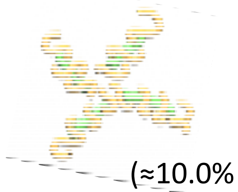
Effects of Particles (omega fatty acids & silymarins) on

- Dough Rheology and Technological Behavior
- Bread Quality Features
- Stability during Processing
- Additional Bioactivity
- Risks Associated

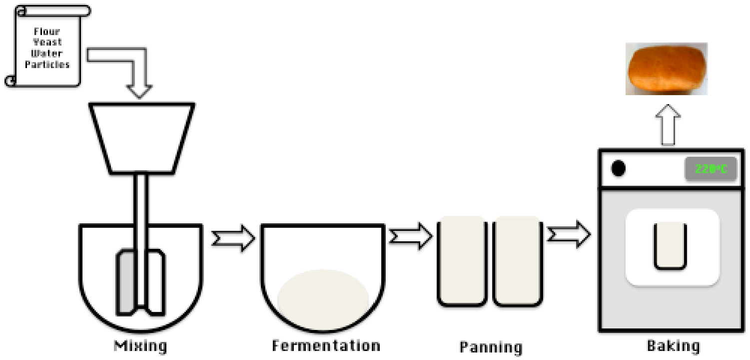
Bread Making Process



Particles of **omega fatty acids** & **silymarins**
None, 1.0%, 2.5%, 5.0%, 10.0%



(≈10.0% core bioactive compound)



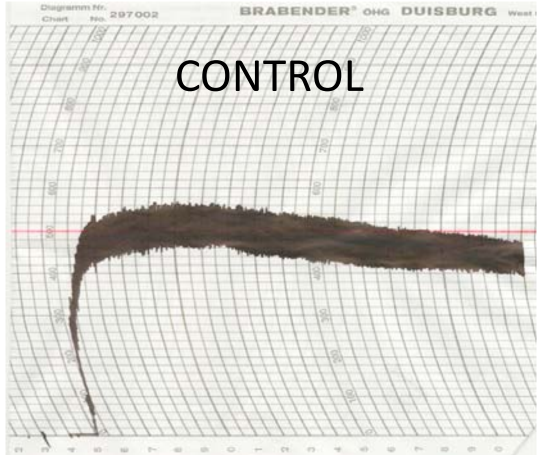
Questions

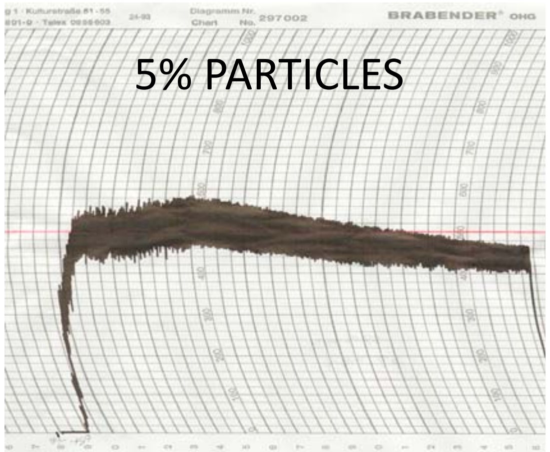
- Do particles have any adverse effect on dough rheology & bread texture?
- Do particles induce any off taste and smell?
- Are particles stable during food processing?
- Do particles have measurable biological actvity?
- Do particles induce any associated risks?

Dough Rheology

<u>Table</u> The mixing properties of the dough with different amounts of nanoparticles

	Amount of Particles, %				
	0%	1%	2.5%	5%	10%
Adsorption, %	62	62	62	65	70
Development, min	4.5	4.5	5.5	6	5
Stability, min	13	13	11.5	13	9.5

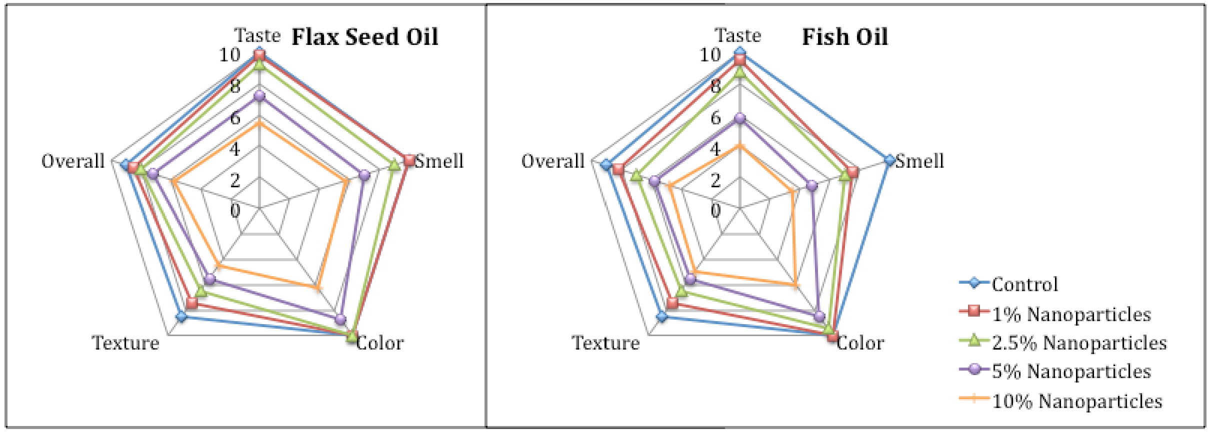




Brabender Farinograph

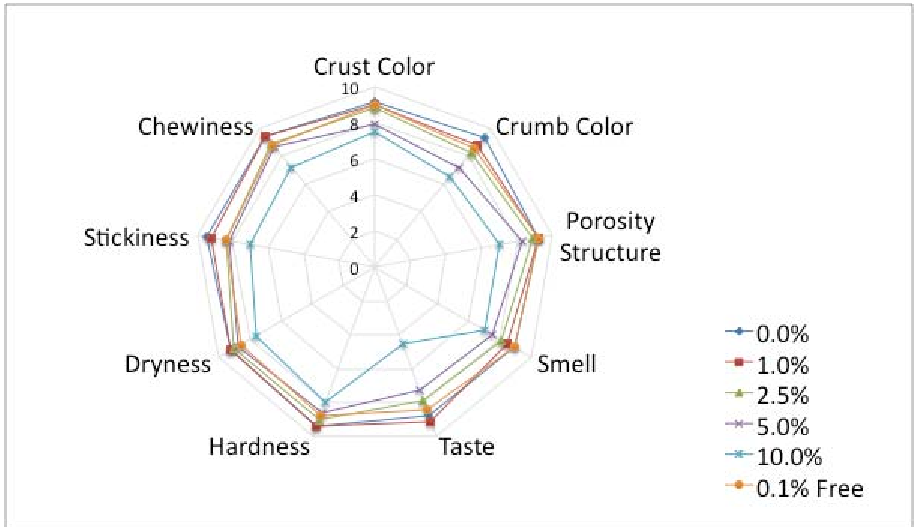
Sensory Quality

Omega Fatty Acids

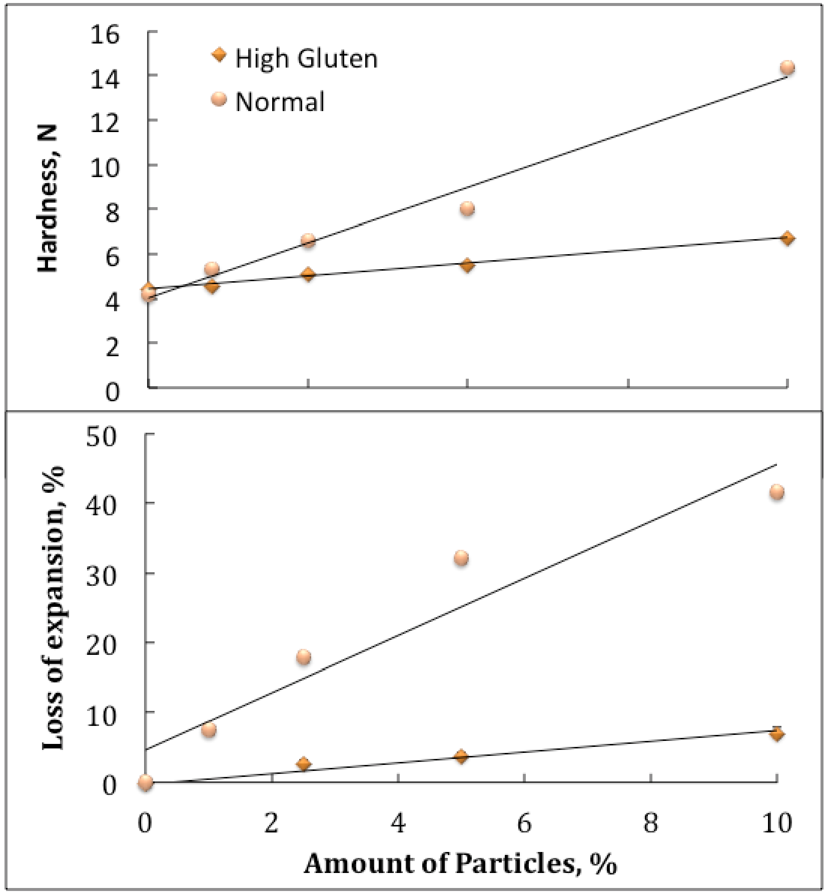


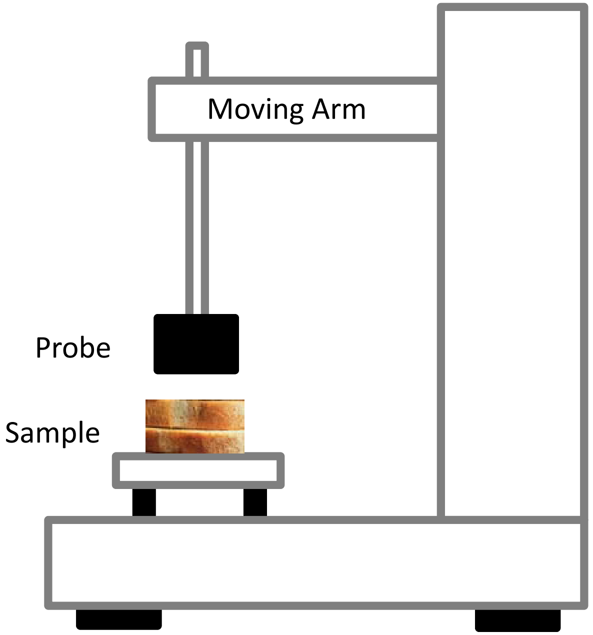
Sensory Quality

Silymarins

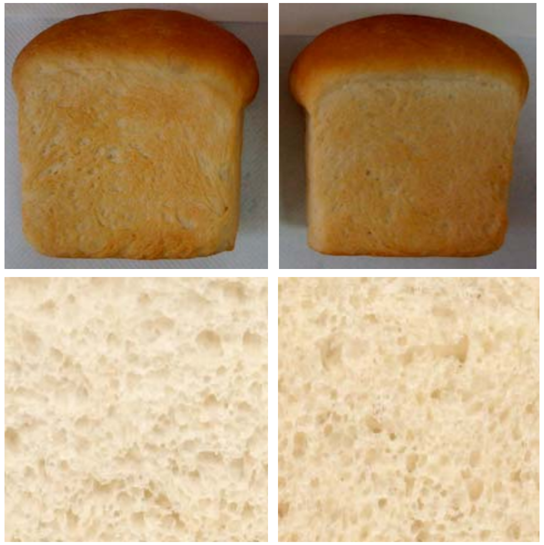


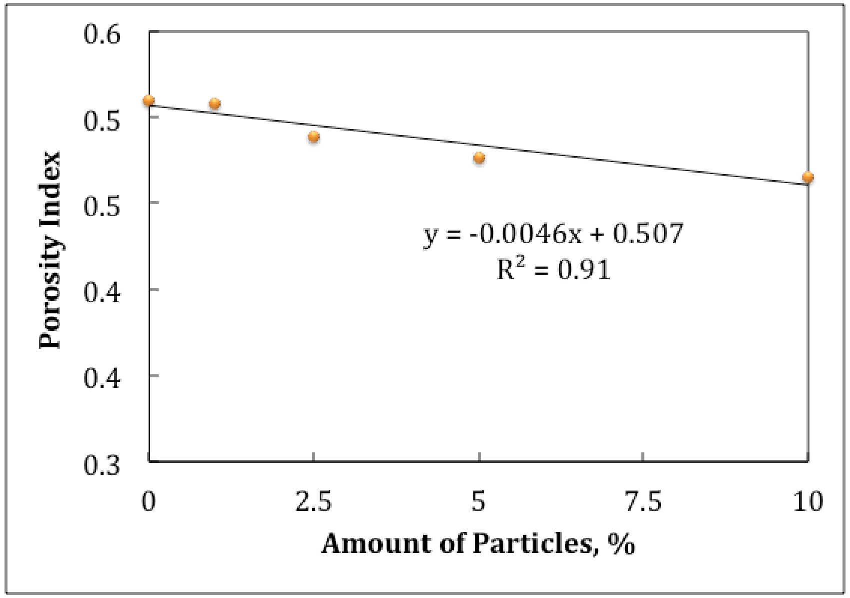
TEXTURE

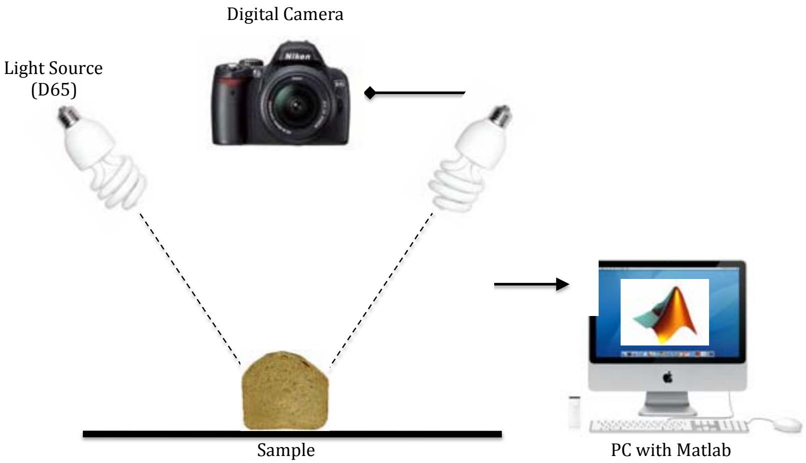

High Gluten
Normal
Hardness, N
16
14
12
10
8
6
4
2
0
Loss of expansion, %
50
40
30
20
10
0
0
2
4
6
8
10
Amount of Particles, %

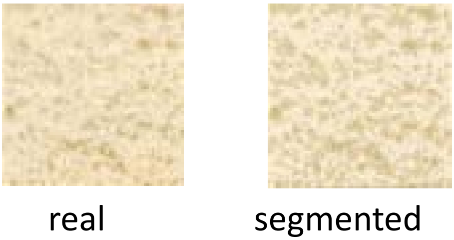

Moving Arm
Probe
Sample

POROSITY



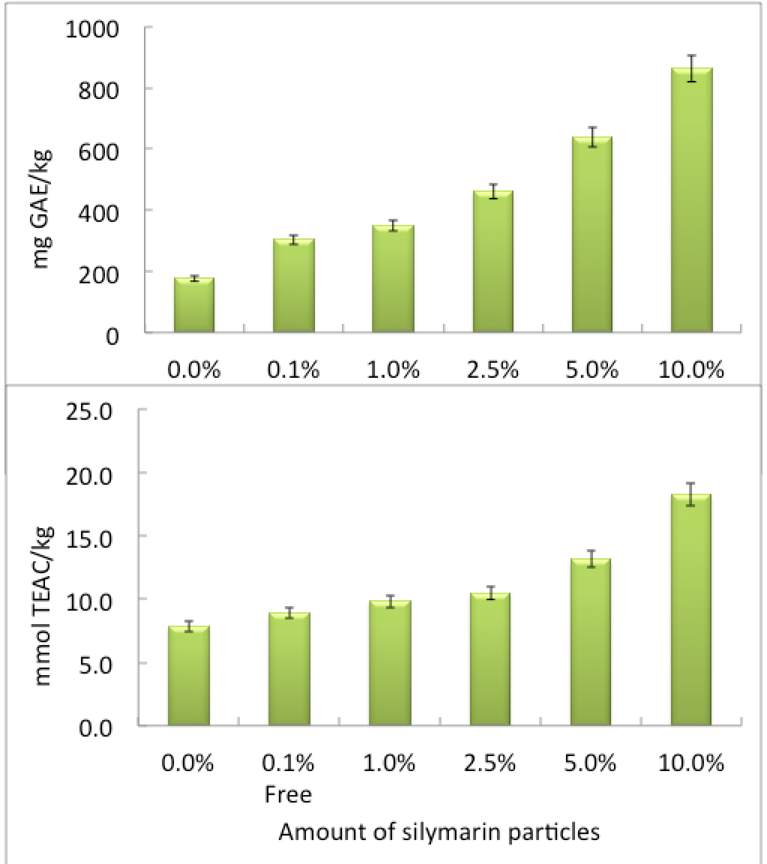






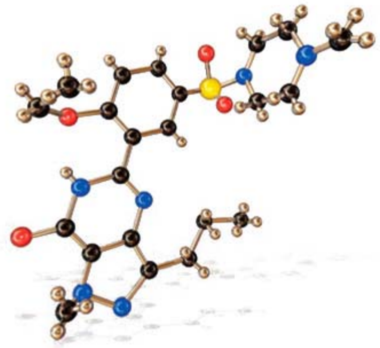
$$Porosity\ Index = \frac{Total\ area\ of\ holes\ in\ a\ slice}{Total\ area\ of\ slice}$$

in vitro bioACTIVITY



Folin-Ciocalteau

QUENCHER with ABTS



HPLC Profile of Silymarins in Functional Breads

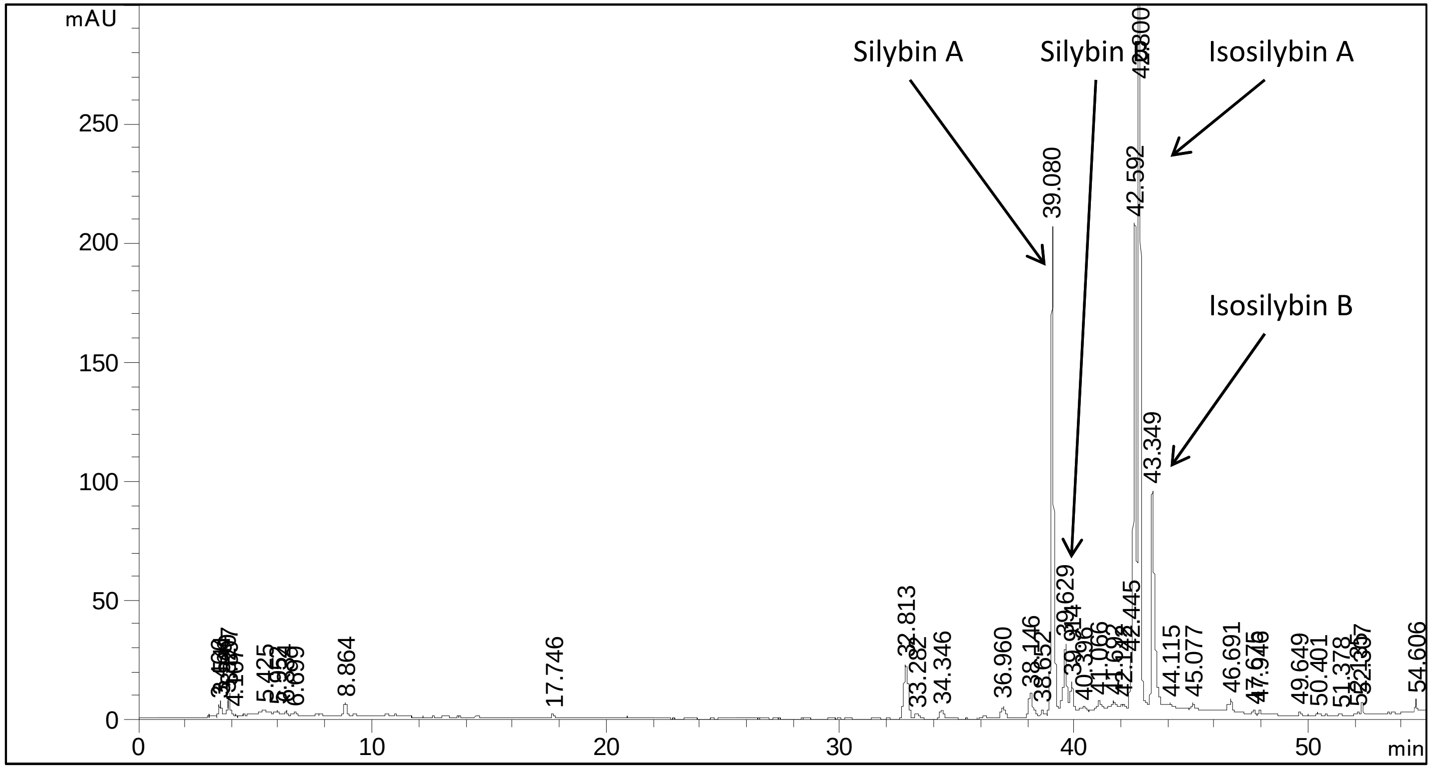
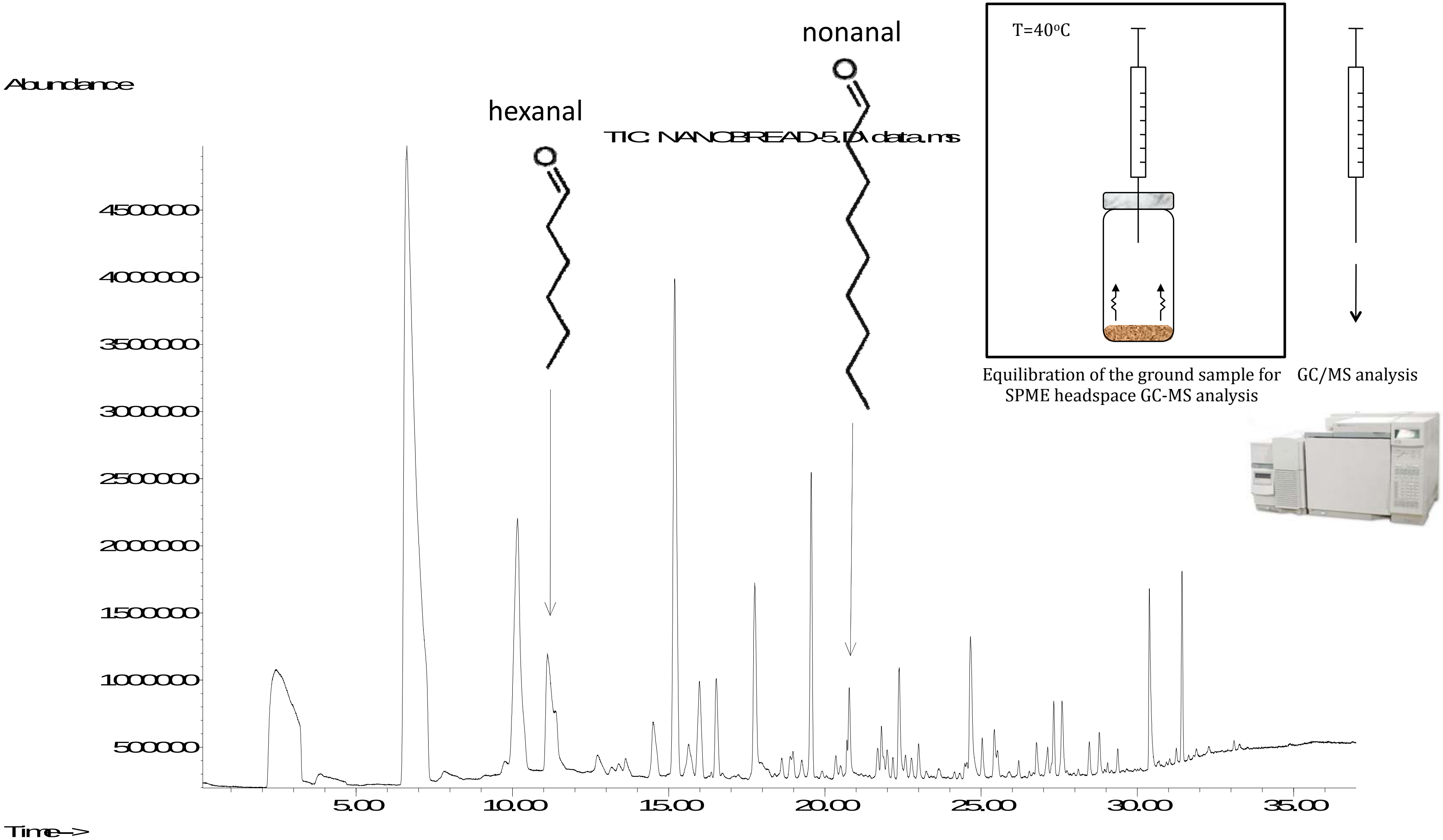


Figure. Chromatogram of phenolic compounds in breads incorporated with 10.0% particles of nano-encapsulated silymarins. *Chromatographic conditions: gradient elution of the mixture of 1% formic acid and methanol at a flow rate of 0.75 ml/min (30^{o}C), column: 250x4.6 mm (id) C12, 5 µm, detection at 280 nm with spectra recording between 200-400 nm for structure confirmation*

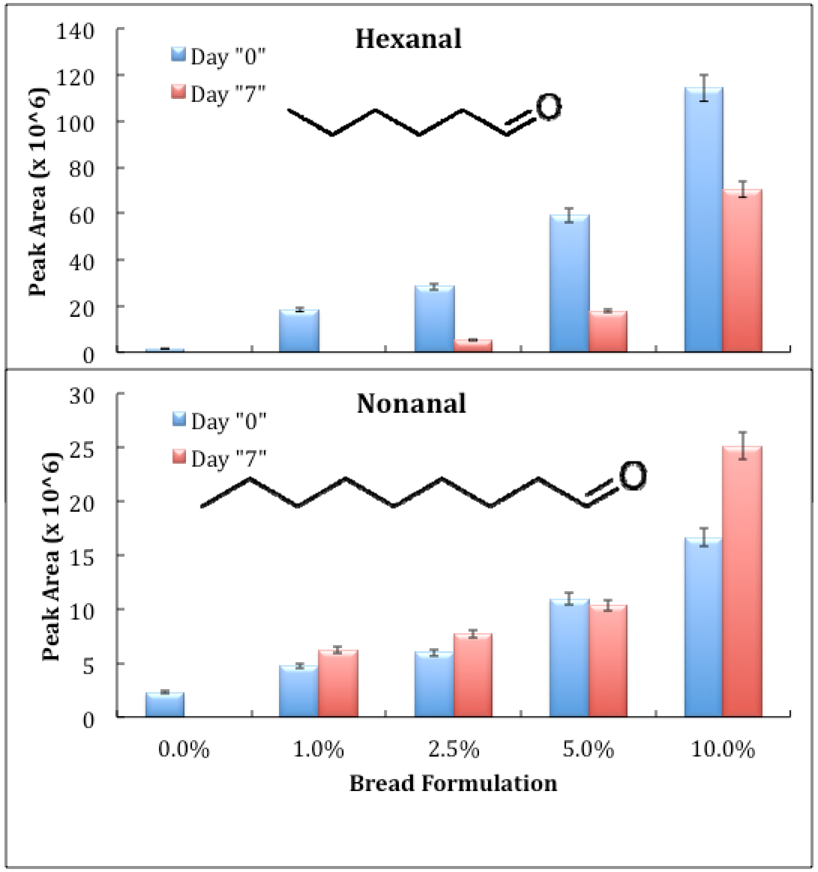
GC-MS Profile Lipid Oxidation Products in Functional Breads



Equilibration of the ground sample for SPME headspace GC-MS analysis

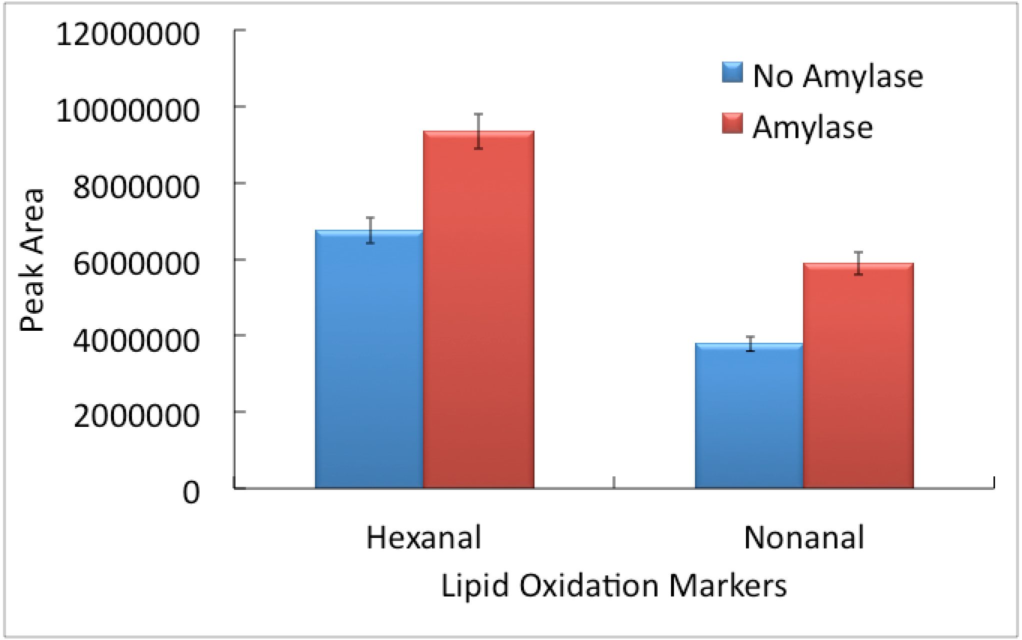
GC/MS analysis

Lipid Oxidation & Shelf Life of Bread



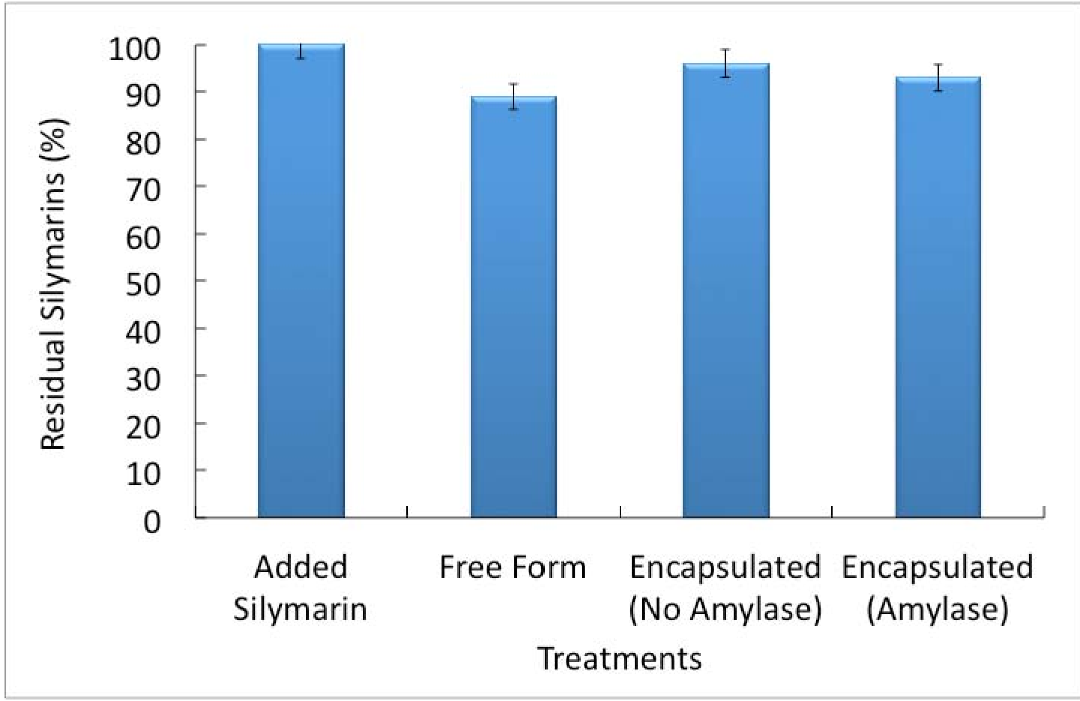
Agilent 5973N GC-MS

Amylase Activity & Lipid Oxidation



SIGNIFICANT

Amylase Activity & Silymarin Stability



NOT SIGNIFICANT !

Amylase Released Silymarins

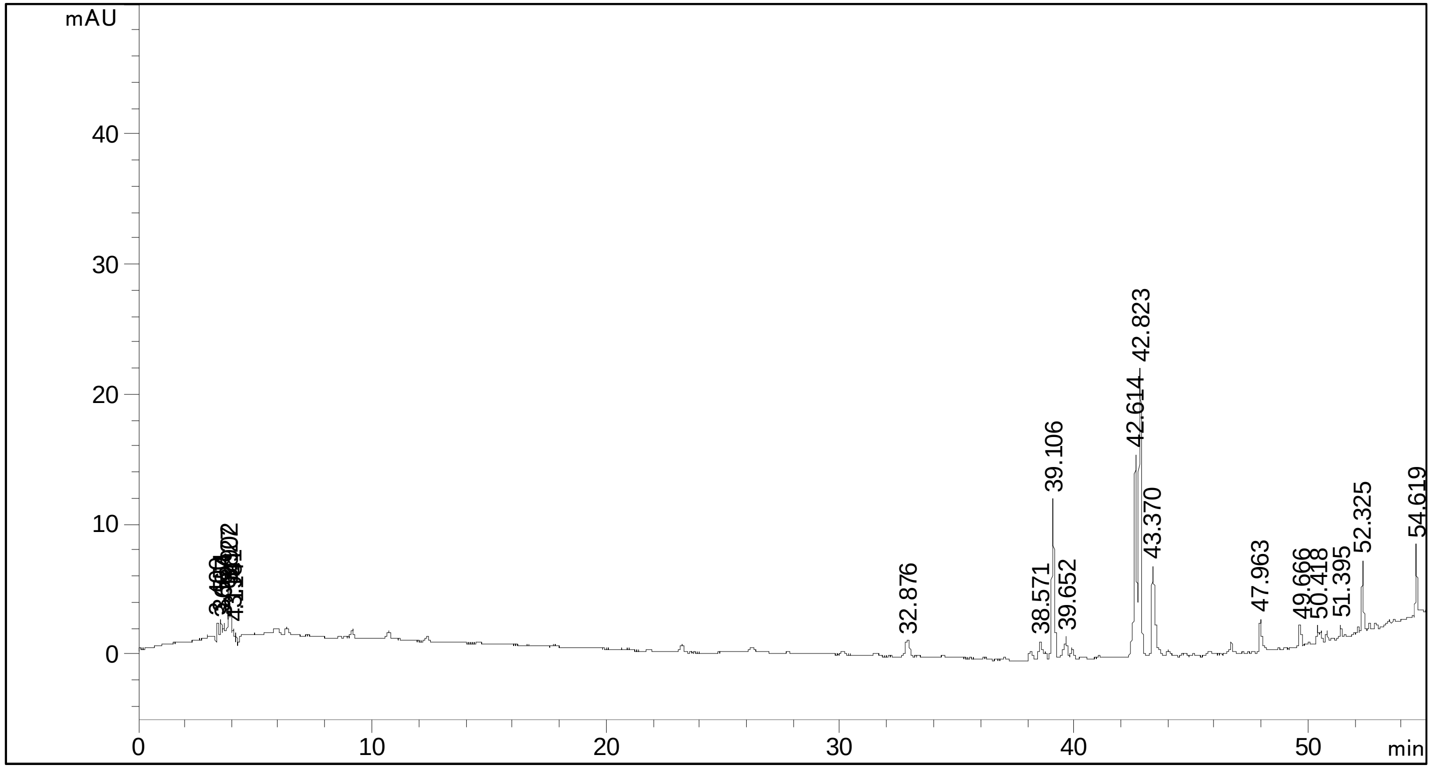
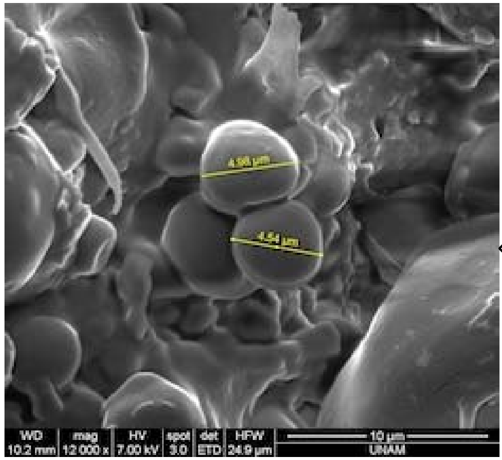


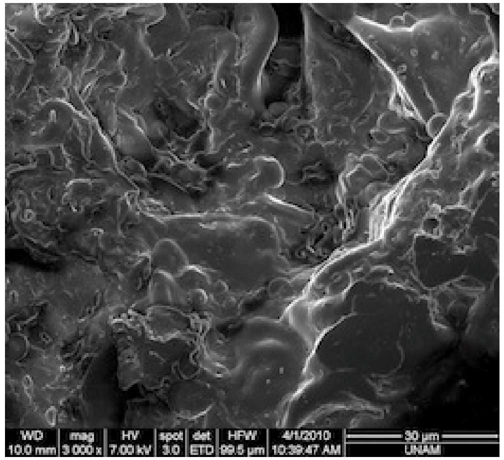
Figure. Effect of amylase treatment on the release of silybin derivatives in breads incorporated with 10.0% particles of nano-encapsulated silymarins. *Chromatographic conditions: gradient elution of the mixture of 1% formic acid and methanol at a flow rate of 0.75 ml/min (30^{o}C), column: 250x4.6 mm (id) C12, 5 µm, detection at 280 nm with spectra recording between 200-400 nm for structure confirmation*

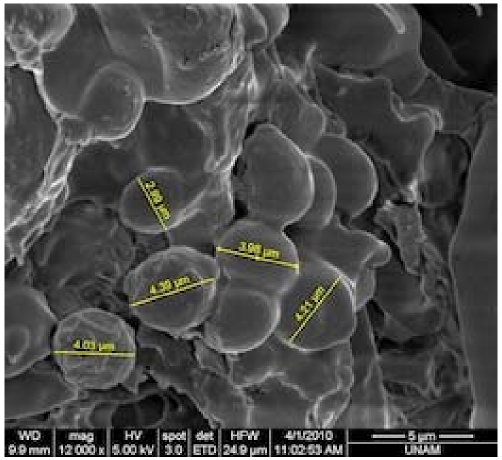
Intact Particles in Functional Bread



CRUMB

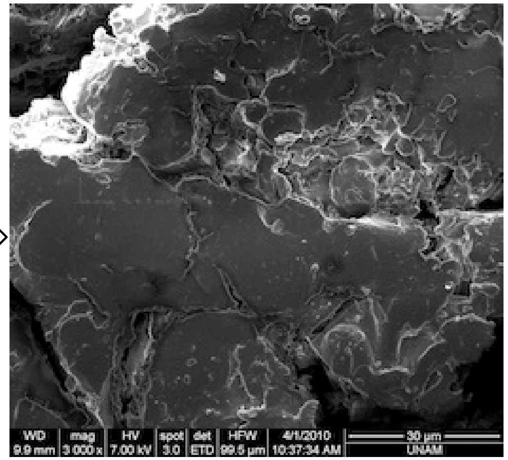
≈100^{o}C



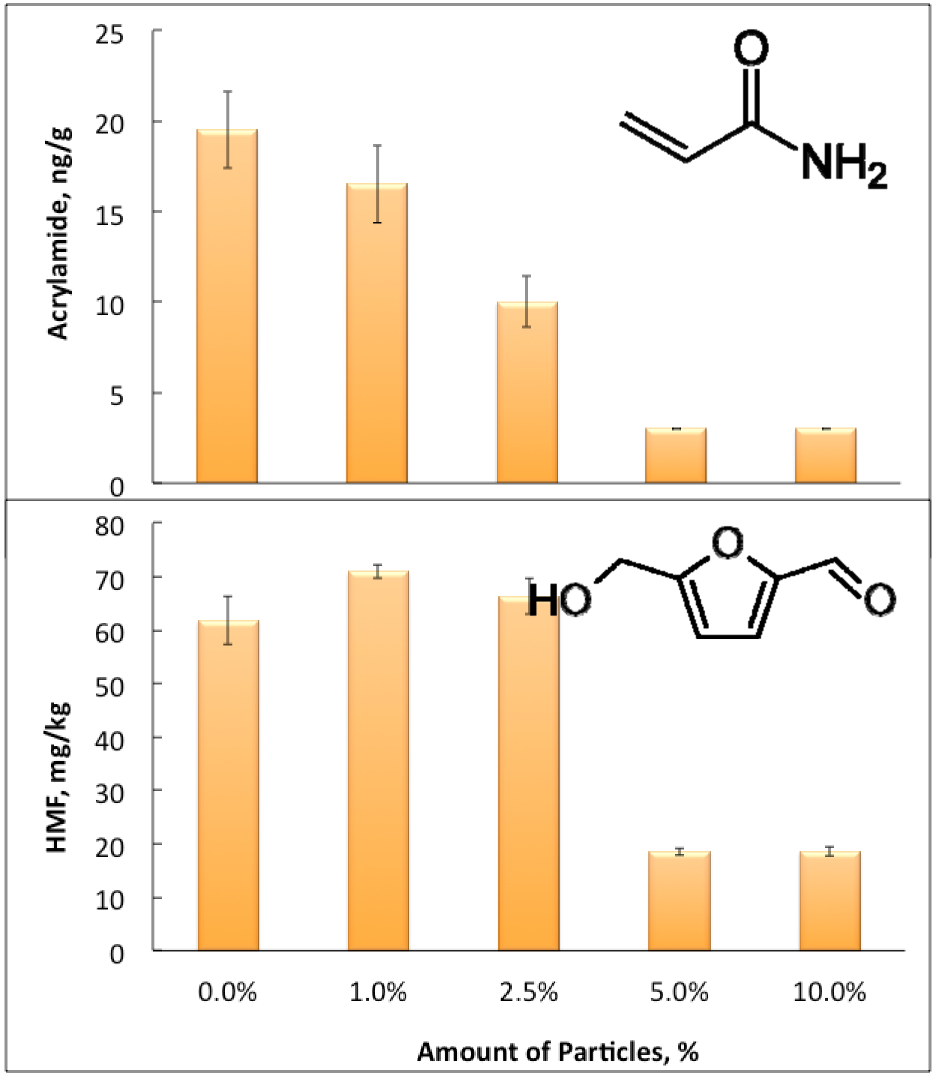


CRUST

>200^{o}C



Risk(s) Associated



<u>Thermal Process Contaminants</u>

Lipid oxidation contribute acrylamide formation !

Particles indirectly reduces acrylamide formation…

Starch based particles increase water holding capacity of dough that further affect t/T history of bread during baking.

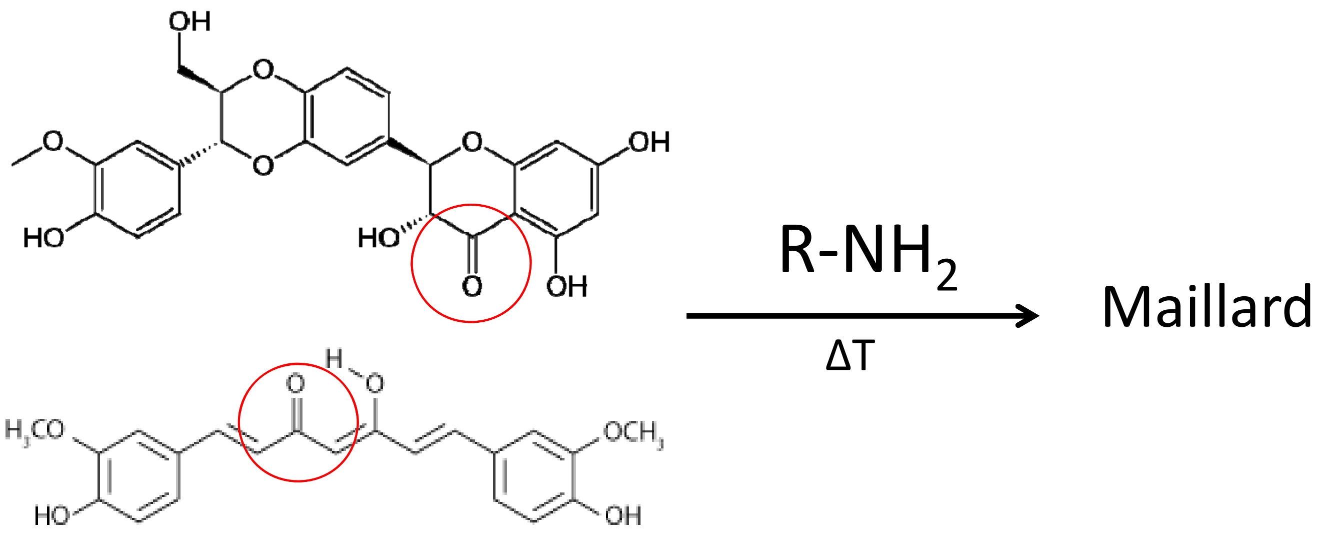
More water means less acrylamide

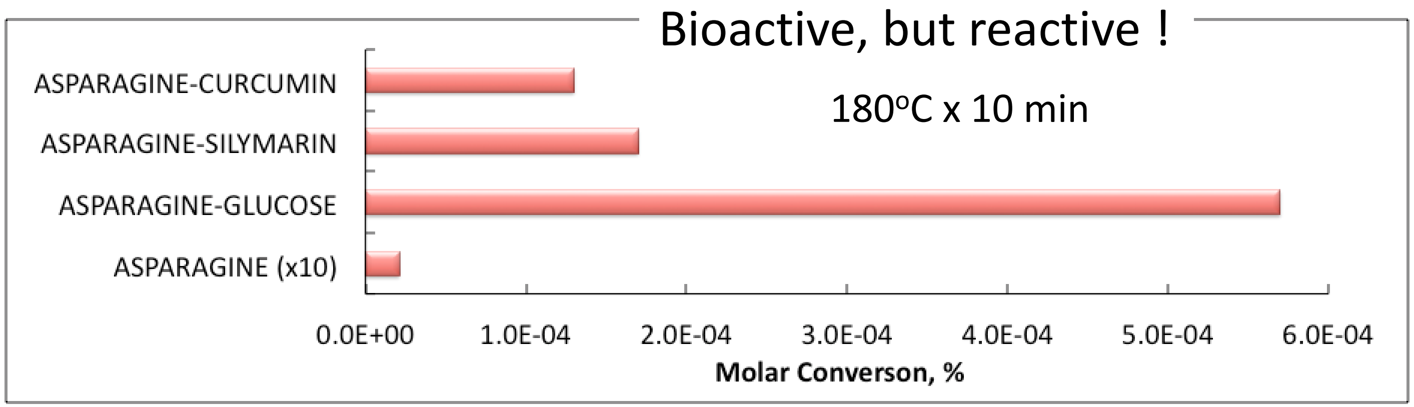
Waters TQD UPLC/MS/MS

Final Words

Silybinin

Curcumin





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