SOLID WOOD CONFORMITY AS FOOD CONTACT MATERIAL

Chemical, microbiological and organoleptic behavior

Executive summary of the main conclusions from

SCIENTIFIC CONSORTIUM "EMABOIS"

(France)

June 2015

Formed by:

ACTALIA

École Supérieure d'Ingénieurs en Emballage et Conditionnement

Oniris – Nantes-Atlantic National College of Veterinary Medicine, Food Science and Engineering

GROUPE ESB – Enseignement – Recherche Sciences & technologies du bois

FCBA

An initiative of the " Wood Packing Pole" participated by:

SIEL GROW – Syndicat National des Industriels de l'Emballage Léger en Bois

SYPAL – Syndicat national de la palette bois

SEILA – Syndicat de l'Emballage Industriel et de la Logistique Associée

France Bois Forêt – Interprofession Nationale

Document translated and adapted by the collaborating entity:

GROW – Group Recycling of Wood

The Research Consortium "EMABOIS" has been formed by:

ACTALIA ASSOCIATION. DEPARTMENT OF DAIRY PRODUCTS
HIGHER ENGINEERING SCHOOL FOR PACKING AND PACKAGING REIMS (ESIREIMS)
NANTES ATLANTIC NATIONAL COLLEGE OF VETERINARY MEDICINE, FOOD SCIENCE AND ENGINEERING, (ONIRIS)
SCHOOL OF WOOD NANTES (GROUP ESB)
TECHNOLOGICAL INSTITUTE OF FORESTRY, PULP, WOOD, FURNITURE AND CONSTRUCTION (FCBA)

The French "Wood Packaging Pole" consists of the following organizations:

NATIONAL UNION OF THE LIGHTWEIGHT WOOD PACKAGING INDUSTRY (SIEL)
UNION OF INDUSTRIAL PACKAGING AND ASSOCIATED LOGISTICS (SEILA)
FNB COMMISSION FOR WOODEN PALLETS. NATIONAL FEDERATION OF WOOD (SYPAL)
INTERPROFESIONAL NATIONAL ASSOCIATION OF WOOD (FRANCE BOIS FORÊT)

FRANCE BOIS FORÊT has mainly funded this project with a budget of 1 million euros.

GROW INTERNATIONAL, it is a collaborating entity of the consortium regarding its dissemination.

This document, translated and adapted in May 2016 by GROW International, is based on the dossier submitted by EMABOIS at a press conference on June 16, 2015 in Paris, where the key findings of the various investigations within the Consortium were presented, after three years of work.

The electronic version of this document is available in www.grow-international.eu

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KEY INFO

THE EMABOIS CONSORTIUM, A SUCCESS:

- ✓ 1st European consortium on wooden packaging
- ✓ Composed by 10 members:
  - 5 research organisations
  - 3 professional organisations
  - 1 interprofessional structure
  - 1 European network for wooden packaging
- ✓ 3 years of study
- ✓ 2 doctoral students
- ✓ 27 scientific associates

SCIENTIFICALLY IT HAS BEEN SUBJECT TO STUDY THE FOLLOWING:

- ✓ 3 types of wood
- ✓ 2 levels of wood humidity
- ✓ 3 agri-food chains studied
- ✓ Over 19,200 tests:
  - > 7,600 tests in chemistry,
  - > 11,600 tests in microbiology

THE RESULTS GIVE A YES TO WOOD

- ✓ 5 now validated methods
- ✓ 0 pathogen
- ✓ 146 harmless volatile molecules
- ✓ 44 acts of scientific communication
- ✓ 4 scientific awards

NOW WE CAN SAY THAT:

- ✓ Raw wood: pine, poplar, spruce is suitable for contact with food.
- ✓ In microbiology, the hygienic safety of the raw wood to food contact surfaces is confirmed.
- ✓ In analytical chemistry, molecules from a natural material, raw wood, are harmless to the health of the consumer. The values of specific migration of volatile compounds from the wood are extremely low.
- ✓ The moisture content of the raw wood is a parameter to adjust based on the sensory qualities sought for contact with.
- ✓ Validation of analytical tools that are simple, reliable and high performing for wooden surfaces in microbiology and analytical chemistry (overall migration, specific migration) is now accepted.

Index

1. Introduction

The wood packaging sector, represented by the National Union of the Lightweight Wood Packaging Industry (SIEL), initiator of first French scientific consortium EMABOIS, launched a research program to meet the demands of its members and French health authorities on the confirmation of the fitness of wooden material for contact with food.

In the context of more stringent regulations concerning packaging in direct contact with food materials, this work responds to the expectations of the General Directorate for Fair Trading, Consumer Affairs and Fraud Control (DGCCRF), the National Agency for Health and Safety in Food, Environment and Labour (ANSES) and the General Directorate for Food (DGAL) regarding the updating of the DGCCRF fact sheet #2012-93 on the suitability of wooden material for food contact (Anonymous, 2012). French health authorities and agencies rely on the European regulation 'EC 1935-2004' demanding (article 3) a better knowledge of chemical, microbiological, organoleptic 'container-content' migration for packaging intended for food contact. Wood is among 17 materials listed by European regulation 'NCE 1935-2004' identified for contact with food.

In France, wood is authorised for contact with food by means of the Order of November 1945 which described a positive list of suitable species for food contact, but also by the information note of the DGCCRF sheet n° 2012-93 'wooden material'.

This is how at the end of 2009 EMABOIS was created: the result of a proactive approach of the wood packaging sector. Currently, the consortium has 10 members. This group formed the first French scientific consortium in the field of wooden packaging.

It is composed of three French professional organizations forming the wood packaging sector:

- SIEL: National Union of the Lightweight Wood Packaging Industry
- SEILA: Union of Industrial Packaging and Associated Logistics
- SYPAL: Commission of the National Federation of Wood Pallet Manufacturers

Together with the inter-professional and fund resource of the consortium:

- France Bois Forêt

And also with 5 French research and/or training institutions:

- Actalia Dairy Products
- ESB: Wood Science and Engineering Institute
- ESIReims: Higher Engineering School for Packing and Packaging
- FCBA: Technological Institute of Forest Wood Cellulose Furniture
- ONIRIS: Nantes Atlantic National College of Veterinary Medicine, Food Science and Engineering

The consortium also has the support of GROW International, Group Recycling of Wood, in work dissemination of results.

Thanks to this special collaboration, both diversity and by the different status of its members, the consortium can avail itself of multiple scientific skills such as: the manufacturing process of wood packaging, chemical and anatomical knowledge of wood products, food safety, food microbiology, quantitative risk assessment, regulatory monitoring and sensory analysis.

EMABOIS stands for 2 types of partnership: one 'internal' where research organisations work closely with the wood packaging sector and a second 'external' where the consortium is in contact with the French authorities and agencies concerned with the control and regulation of food.

The focal point of the consortium is the sanitary control and sensory benefits of using lightweight packaging, pallets and wooden industrial crates for the storage and conservation of food products.

The objectives of the EMABOIS consortium are, firstly, to contact by way of the trade press, the consumer, to participate in working groups and in scientific symposia; and on the other hand, the support of scientific studies to develop analytical methods to quantify chemical, microbiological and organoleptic migration between wooden supports and food matrices.

It does this for the purpose of self-regulatory checks and expertise for the wood packaging industry.

These studies were devoted to 3 important French users of wood packaging, the 'fruit and vegetables' industry sector, the 'milk and dairy products' sector and the 'seafood' sector.

The results speak for themselves: The protocols now exist. They are very favorable towards wood, and have been made public.

2. Chemical behavior

Analysis tools

Scope of the study

This study was carried out by the engineering schools École Supérieure du Bois - ESB (Nantes) and École Supérieure de l'Emballage - ESIReims (Reims).

In analytical chemistry, there was no data available three years ago.

The test conditions look at 2 species of raw wood: poplar veneer and sawn pine (origin: France) used in France for the manufacture of wooden packaging. The wood has been studied at 2 humidity levels: 13% (dry) and 36% (wet) and 2 wood zones: sapwood and heartwood, in contact with 3 food simulants as a replacement for real foods: simulant A: Ethanol 10% aqueous feed, simulant D: Ethanol 95% for fatty foods and simulant E: TENAX© for dry foods.

The tests were conducted at temperatures of 4°C and 23°C based on durations of contact ranging from 1 hour to 10 days and reflecting conditions encountered in the field.

'Wood/food packaging' contact surfaces

The results presented in this part of analytical chemistry rely on contact cartography mapping data 'wood-food packaging'.

Thus, the overall and specific migration data, presented below, have integrated correction factors corresponding to the actual surfaces of contact between the wood packaging and the food.

In fact, we must be aware that the inner surface of a keepnet makes contact with just 3% of 2 dozen oysters. Another example, the apple crate makes contact with only 11% of 8 kg of bulk loose apples and a salad crate makes contact with only 22% of 6 salads.

This data also allow us to highlight a striking decrease in the risk of food contamination and therefore of the consumer.

As stated earlier, the primary goal of the consortium was to provide the French wood packaging industry with analysis methods to quantify migration from wood to food, particularly chemical migration.

Overall migration

Analytical chemistry analysis tool for overall migration

With this data, the objective was to meet French and European regulations which require tools for the chemical analysis of materials in contact with food for overall migration and specific migration.

Overall migration takes into account the total mass ceded by a material to a food. Specific migration takes into account the migration of a single compound.

Thus, the approach taken to calculate the overall migration was to validate methods for obtaining migrants, then perform an analysis on migrants to obtain innovative data concerning the overall migration of poplar veneer and sawn pine. The migrant is the set of molecules that have migrated from the material to a food.

Here we describe the gravimetric method followed to obtain data in overall migration for poplar wood and maritime pine:

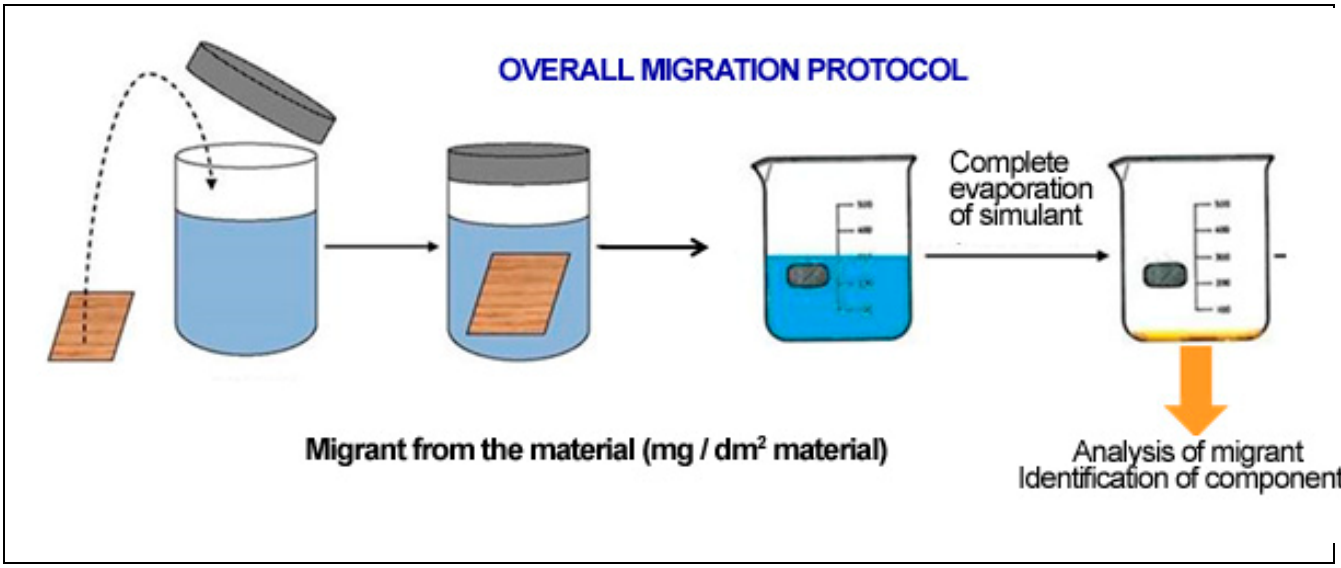

Figure 1: *Gravimetric method for the overall migration of poplar wood packaging and maritime pine*

The migrants are obtained by contact between the sample of raw wood and a liquid simulant at a given temperature and for a specific duration of contact. Then the solution is subjected to evaporation in order to obtain the mass of the resulting migrant of the material. Finally, the migrant is analysed by different analytical chemistry techniques to identify the molecules present.

This analytical chemistry analysis tool, robust and adapted to wood materials, could become a certification procedure for wood packaging for food contact required by the European and French regulations.

Molecules present in the migrant are then identified by means of 3 different techniques whose objectives are:

- Infra-red to characterize chemical functions present in a molecule
- LC-ESI-MS (liquid chromatography coupled to mass spectrometry) to characterize the non-volatile compounds after separation
- And GC-MS (gas chromatography coupled to mass spectrometry) to characterize the volatile components after separation

In our study framework, these advanced analytical chemistry techniques, robust and adapted to wooden material, could become certification procedures for wooden packaging suitable for food contact required by European and French regulations.

Key results

Significant results for the overall migration of poplar and pine, after more than 4800 tests carried out, are:

- ✓ Molecules identified in overall migration are harmless to the health of the consumer. Indeed, we can cite examples of migrants identified with the vast majority such as sugars,

fatty acids, carboxylic compounds as well as molecules such as glycerin, syringol, methyl-pyruvate used in medicine and in the food industry.

- Glycerin: improves the smoothness of pharmaceutical preparations
- Syringol: 'smoked' flavour, volatile phenol
- Methyl-pyruvate: dye used in pharmacy and agrochemistry

✓ When in contact with 'wood-food' at 4°C and 23°C, temperature does not significantly influence the overall migration.

✓ The moisture level of the wood does not influence the overall migration.

Specific migration

Analytical tools

Following the results obtained in the overall migration, an identification of volatile molecules migrating from wood to a food simulant was carried out for specific migration, whose definition is the value of the migration of a specific compound.

The specific method used in this case is TD-GC/MS for thermal desorber coupled with gas chromatography and mass spectrometry with a dry food simulant: Tenax©. This was conducted on more than 1,500 tests.

The protocol analysis of wooden material in obtaining specific migration data is the following:

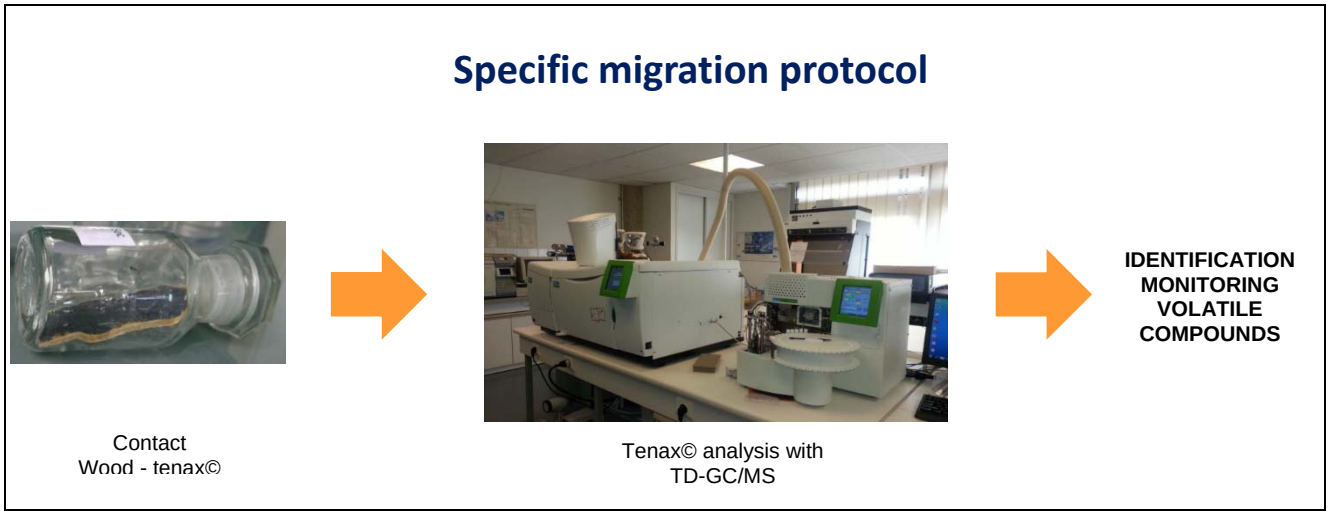

Figure 2: *Method by TD-GC/MS for the Specific Migration of packaging with poplar wood and maritime pine*

After contact between the wood sample and the Tenax©, the Tenax© is analyzed in TD GC/MS for the identification of volatile compounds using the basis of identification available within different databases.

In our study framework, this specific analytical chemistry technique, robust and adapted to wooden material, may support the certification of its suitability for food contact required by European and French regulations.

Key results

After more than 1500 tests carried out for the development and calculation of specific migration of volatile molecules from raw wood, significant results for the Specific Migration of poplar and pine are:

- ✓ -Identification of 146 harmless volatile molecules from poplar and pine including 42 common molecules.

To know if these molecules were subject to regulations for food contact and in particular the following: production, labelling, conditions of use, changes in organoleptic properties of food in contact, the approach recognized by the FDA and EFSA has been applied. Indeed, this approach demands TTC (Threshold of Toxicological Concern) which is a probabilistic method for comparing chemical molecules structures that are NOT carcinogens, endocrine disrupters, or molecules liable to bioaccumulate, nanomaterials, or radioactive or pharmacologically active substances.

This first level of analysis is coupled with Gcomply software (Decernis) to ascertain whether the identified molecule is subject to regulations for food contact in 170 different countries. The scientific literature on the results obtained with Tenax© has also been taken into account.

This approach has allowed us to demonstrate that 146 molecules have been recognized by the TTC database as harmless for the consumer, as they are not carcinogens, endocrine disrupters, nor are they likely to be molecules susceptible to bioaccumulation, nanomaterials, radioactive substances or pharmacologically active substances.

It was also revealed that 4 out of 5 molecules are regulated in the field of food including the conditions of use (on what foods, hot vs cold), labelling, changes in the organoleptic properties of the food in contact...

And 1 molecule in 5 is not regulated in France for the food industry due to their ordinary chemical properties, such as α-fenchol and 9-hexadecen-1-ol which are not included, p-cymen-8-ol found in the essential oil of watercress leaves, furfural used in flavoring with a spicy odour, 4-terpineol, α-terpineol and β-terpineol found in pine essential oil and used in aromatherapy, or molecules subject to other specific regulations for other application areas, for example in cosmetics for 2.2 dimethyl, 3-methylene-biclyclo[2.2.1]heptane, and for example in other countries such as Australia, cubebol is authorised as a flavoring.

Secondly, to support the results described above, some specific migration measurements were rigorously tested in migration scenarios (more than 1,300 tests). Of these 146 molecules, 7 chemical families have been identified.

So one molecule per family was selected and the specific migration of these 7 molecules was studied. It appears that the maximum observed specific migration is 0.7 mg/kg of food simulant (Tenax©) for hexanoic acid (used as a food flavouring and without specific migration limit) which is synonymous with negligible migration.

In this framework, there is no argument for the non-use of wood for direct food contact.

3. Microbiology behavior

Analysis tools

Scope of the study

ACTALIA (La Roche sur Foron) and FCBA (Bordeaux) technical institutes together with the agri-food and veterinary school ONIRIS (Nantes) conducted this study.

The study in microbiology on wood in contact with food has benefited from previously acquired results. For this study, the test conditions were the single use of raw wood for 3 species used in wooden packaging in France: poplar veneer, sawn pine, and sawn spruce. The wood has been analyzed at 2 humidity levels: 18% (dry) and 37% (wet) reflecting the terms of use on the ground. Migration of microorganisms was studied for 3 microorganisms identified as the corresponding dangers to the 3 sectors studied (fruit and vegetables, dairy products and seafood) and in the case of direct contact, with 2 real foods: apples (dry food) and cheese (fatty and humid).

Contact surfaces for 'wood-food packaging'

The results presented in the microbiology section rely on cartography contact data 'wood-food packaging' obtained according to the protocol below:

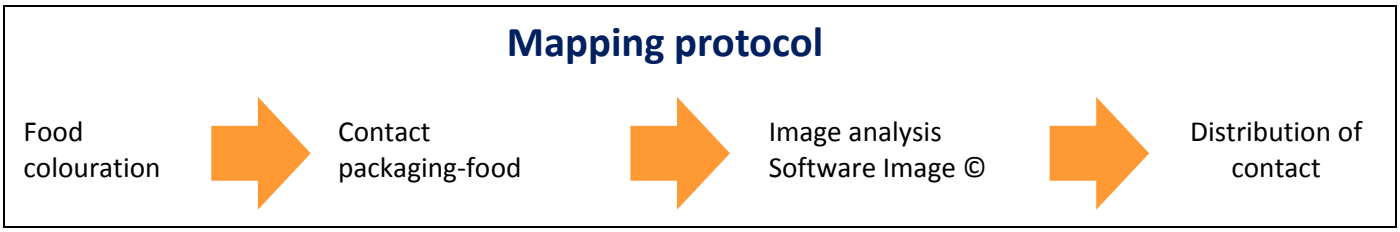

Figure 3: *Contact mapping protocol 'wood-food packaging'*

This innovative data helped to identify the adequate sampling zone for microbiological analyses on the wooden packaging corresponding to scenarios of severe eventual migration. For example in apple crates, samples must be taken from the bottom of the crates.

Microbiological analysis tool for wood components less than 5 mm thick: grinding

As stated previously, the primary objective of the consortium was to equip the French wood packaging industry with analytical quantification methods, including for the microbiological migration of wood towards food.

For this, a first analysis tool has been validated for wooden items less than 5 mm thick: grinding (Ismaïl, Le Bayon et al., 2014). For this, wood is ground using a mill and then the chips are put in contact with a water and peptone solution (a medium suitable for the survival of microorganisms) to extract the microorganisms in the wood. The liquid is then used for the identification of microorganisms in accordance with applicable standards (Figure 2).

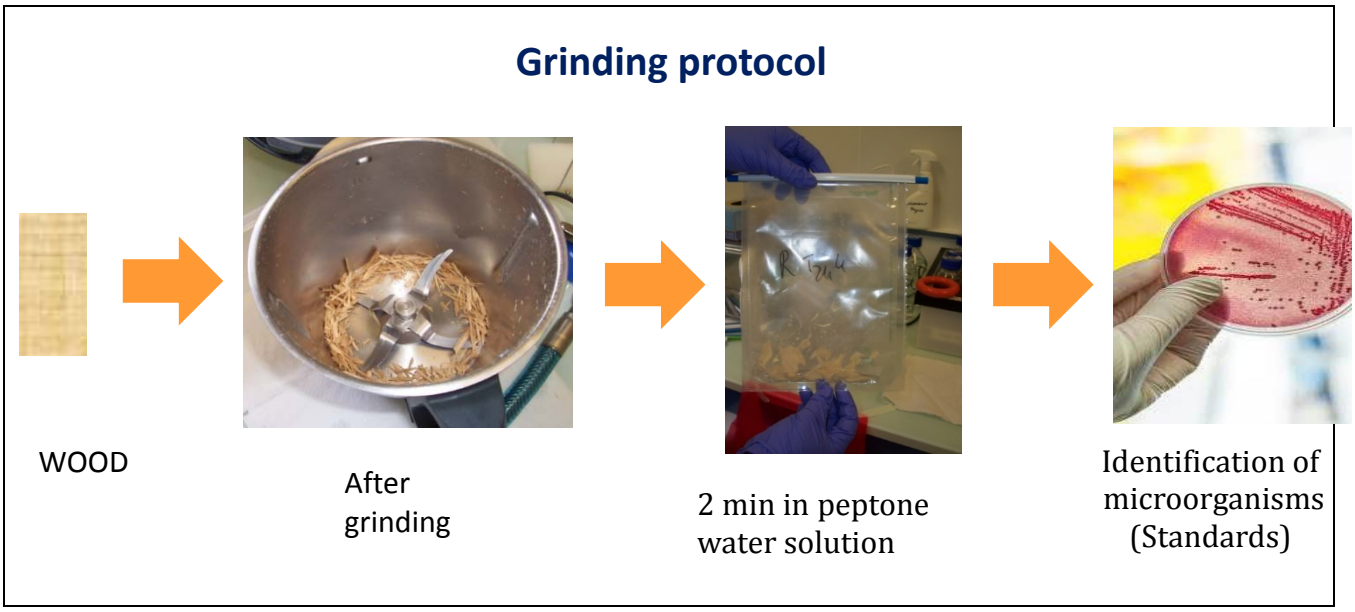

Figure 4: *Analysis tool for wooden elements of less than 5 mm thick: grinding*

In our study framework, this microbiological analysis tool, robust and adapted to wooden materials, could become a certification procedure for wood packaging suitable for food contact as required by European and French regulations.

Microbiological analysis tool for wooden elements more than 5 mm thick: planing

A second analysis tool has been validated for the wooden elements of more than 5 mm thick: planing (Ismaïl, Le Bayon et al., 2014). In this case, the wood is planed, then the shavings are put in contact with a water and peptone solution (medium suitable for the survival of microorganisms) to extract the microorganisms in the wood. The liquid is then used for the identification of microorganisms in accordance with applicable standards (Figure 3).

Planing protocol

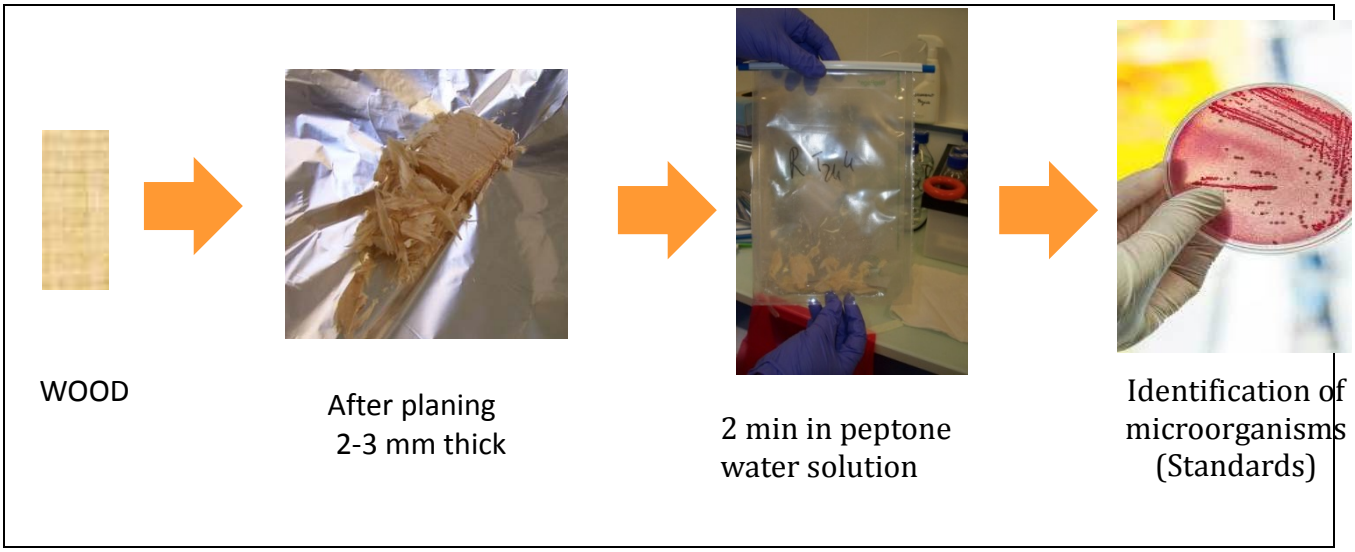

Figure 5: *Analysis tool for wooden elements of more than 5 mm thick: planing*

In our study framework, this microbiological analysis tool, robust and adapted to wooden materials, could become a certification procedure for wood packaging suitable for food contact as required by European and French regulations.

Key results

These microbiological analysis tools of wooden surfaces allowed the following key facts to be identified:

Microbiological safety of wood with regards to food in direct contact

A field analysis was performed with the planing method, described above, for the extraction of microorganisms from the wood.

The choice fell on spruce maturing boards at different stages of their method of manufacture and use representing more than 3800 tests and equating to the analysis of 108 maturing boards. Indeed, spruce is a wood traditionally used for the maturation of cheese in the form of boards, and is authorised for direct food contact (AFSSA, 2008; ANSES, 2011).

In the case of maturation, microbial ecosystems present on the spruce boards may have an inhibitory effect on Listeria monocytogenes (Mariani, Briandet et al., 2007).

The purpose of this study was to remove microorganisms from the surface of the maturing boards and quantify them according to standards in force for the milk and dairy product industry. The 108 samples were analyzed 3 times each to ensure the robustness of the results.

The results show that for spruce boards in manufacturing output, or stored ready for use: no pathogen has been identified. This result is in favor of the microbiological safety of wood with regards to food in direct contact.

Drastic reduction in the number of microorganisms on the wood

Another important result was observed: the drastic reduction in the number of extracted microorganisms in the wood after 24h of contact with poplar, pine and spruce as shown in the following graph:

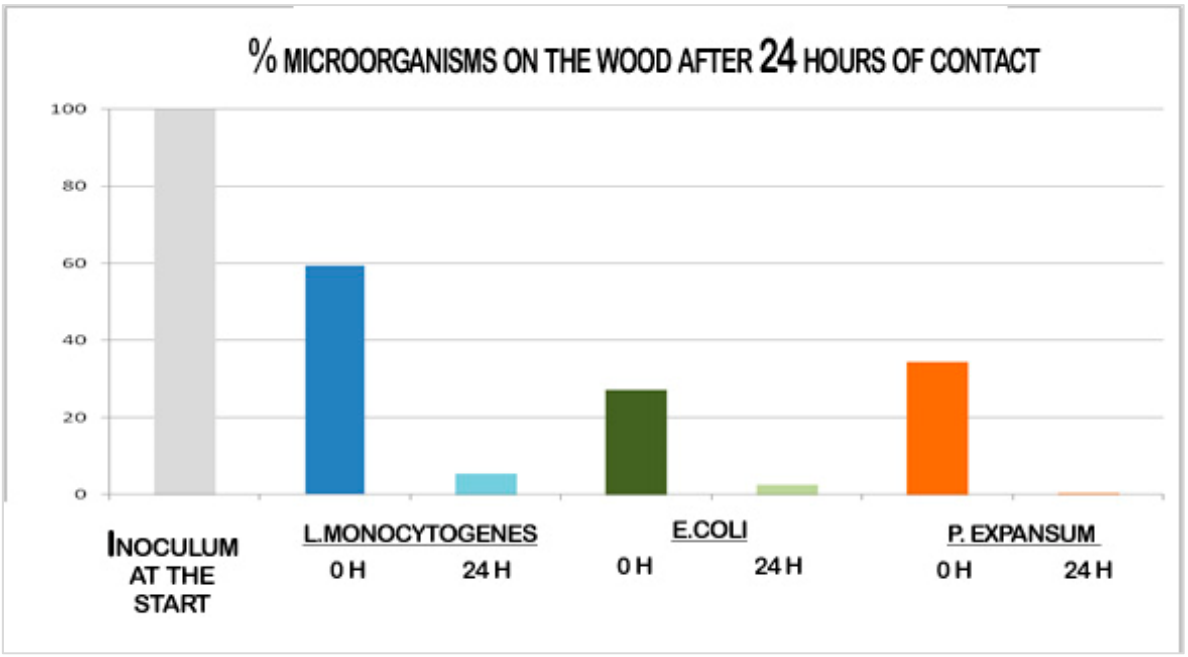

Figure 6: *Percentage of microorganisms on the wood after 24 hours of contact*

After 24 hours of contact with the wood, the microbial population is divided by 20 or even 200!

Indeed, the drastic reduction of the microbial population after 24h of contact with the wood surface leads to different conclusions:

- ✓ The porosity of the wooden material would be a benefit for the hygiene of surfaces because it 'entraps' microorganisms preventing their survival and their multiplication.
- ✓ The anatomy of wood leads to a drying of microorganisms due to its hygroscopic properties coupled with the absence of nutrient intake during the 24h.

99% of microorganisms DO NOT MIGRATE to the food

99% of microorganisms inoculated on wood do not migrate towards dry food or aqueous and fatty food as indicated on this graph:

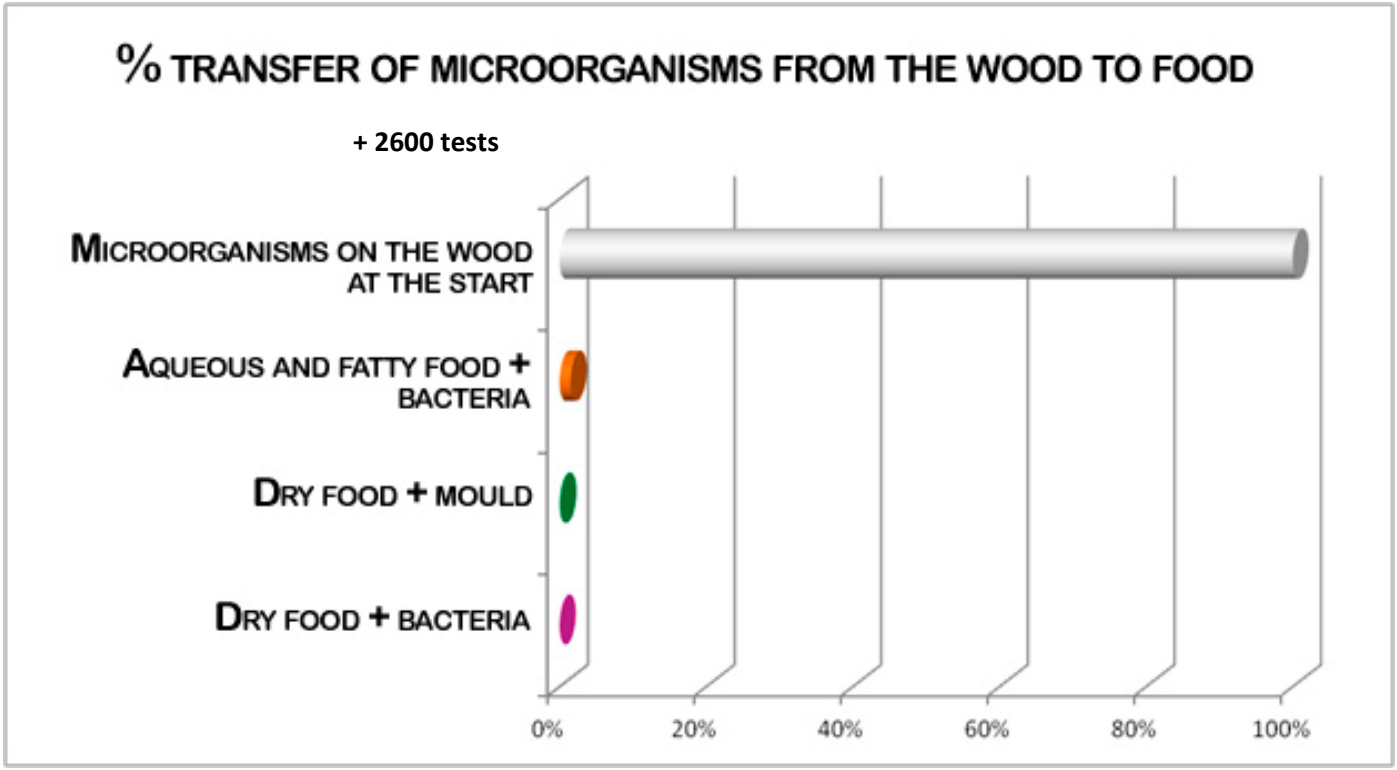

Figure 7: *Percentage of transfer of microorganisms from the wood to food*

This is a consequence of the phenomenon of sudden dryness of the microorganisms on the surface of the wood that prevents the survival and multiplication of microorganisms, as has already been demonstrated in the case of spruce for Listeria monocytogenes (Mariani, Oulahal et al., 2011) and poplar for certain bacteria (Revol-Junelles, Miguindou-Mabiala et al., 2005).

These are very interesting points also for the wood packaging industry, in that the moisture content of the wood and the nature of the food do not affect microbiological migration of wood towards food.

Transfer of microorganisms: comparison of the 3 packaging surfaces of glass, plastic and wood

Regardless of the type of wood, the transfer of microorganisms from the wood to food is lower than glass and plastic as shown on the graph:

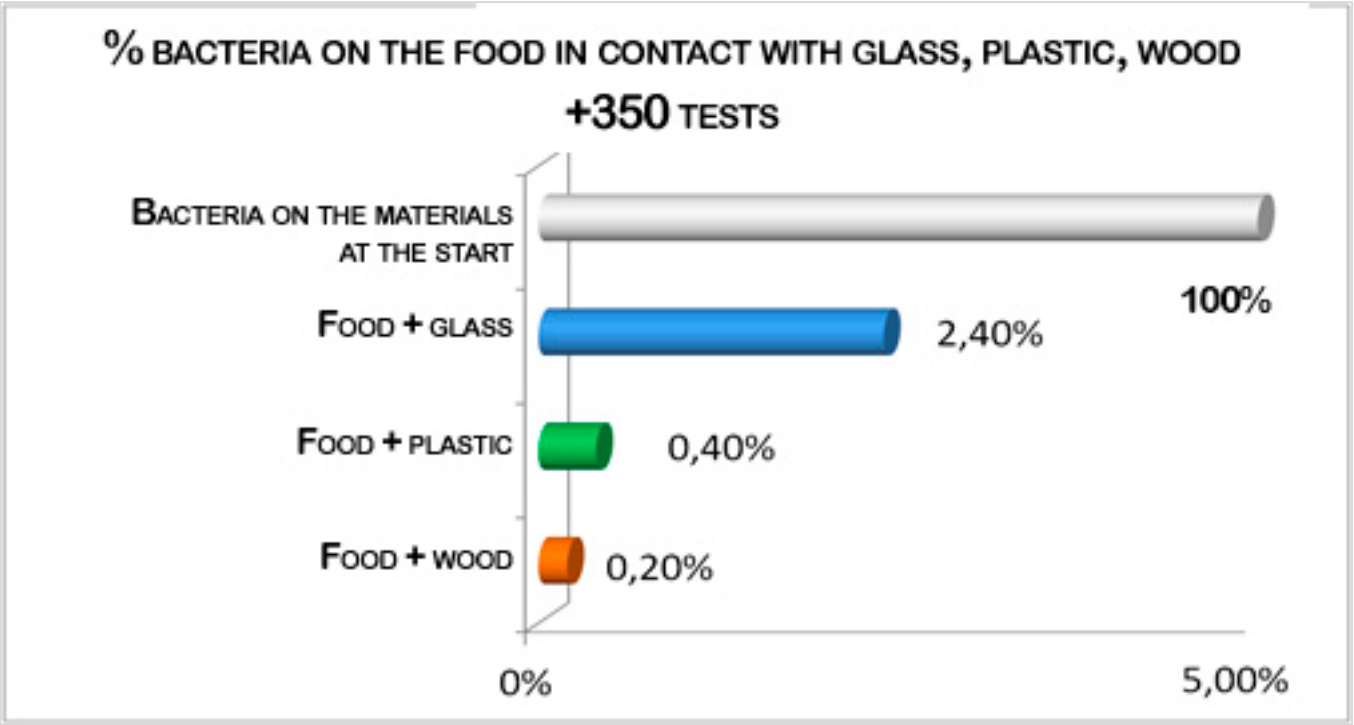

Figure 8: *Transfer of microorganisms: comparison of the 3 packaging surfaces of glass, plastic and wood*

Thus, we can no longer oppose wooden material as being non-hygienic as it has the lowest microorganism transfer rate.

4. Sensory behavior

Scope of the study

The quality of a food especially depends on its interaction with packaging. In addition to the non-transfer of chemical and microbiological contaminants to food, packaging must not damage its organoleptic properties by transmitting unwanted flavours.

The exchange of volatile compounds from wood and food, compared to other packaging, has been little studied. However, wood could be an interesting alternative to other packaging materials for specific uses. It has been shown that keeping wine in wooden casks confers specific aromatic properties.

In addition, it has been shown that wines aged in wooden vats had different volatile compounds of those aged in stainless steel vats (Chatonnet, Dubourdieu et al., 1992; González-Marco, Jiménez-Moreno et al., 2008).

Objective of the study

The objective of this study was to compare odours between food models in contact with wood and glass after 1 week in a cold room (+4°C) (Arvisenet and Aviat, 2015). Poplar and maritime pine were selected and studied at 2 levels of humidity: dry (20%) and wet (40%).

It should be noted that in this study, the woods were cut transversely to foster the diffusion between the wood and the food model in contact with it. Thus, these results were obtained in extreme conditions for the diffusion of volatile compounds. As a matter of fact, crates, bins and boards are usually cut in a radial manner.

Key results

It appears that differences in smells were perceived by a sensory panel for the conditions of the study, that is to say one week of contact at +4°C.

Indeed, the food models in contact with the glass were distinguished from those in contact with the wet and dry poplar and the wet pine.

On the other hand, the panel was unable to distinguish between the food models in contact with glass and those in contact with the dry pine.

Therefore, wood humidity influences the composition of volatile compounds that migrate and therefore influence the sensory properties of the food.

As a consequence, it would be possible to adapt the species of wood and the humidity level sought for direct food contact.

For example, a wood that allows diffusion of volatile compounds can be chosen to influence the organoleptic characteristics of food (in the case of French cheeses) or also a wood that will not transmit odours to the food may be preferred.

5. Innovative analysis tools

The strengths and innovations of these methods are:

- ✓ A response to the French health authorities and agencies and French wood packaging French industry on robust and high performing analysis tools appropriate for wooden material as required by European and French regulations.
- ✓ The robustness of these tools* evaluated by the number of tests carried out:
  - o more than 11,600 tests performed in microbiology
  - o more than 7,600 tests performed in chemistry
- ✓ Evaluated through the rigorous validation of these tools.
- ✓ Evaluated by the development of analytical tools in severe conditions for chemical and microbiological migrations from wood to food.
- ✓ The practicality, simplicity and speed of implementing these tools in analytical laboratories for materials in contact with foodstuffs with devices described previously is an undeniable asset.
- ✓ Analytical laboratories can use the protocols of these methods of analysis published in scientific articles (Ismaïl, Le Bayon et al., 2014) and science thesis (Ismaïl, 2015; Ludosky, 2015).

6. EMABOIS conclusions

In the context of sustainable development, which is being greeted with a new enthusiasm and strong momentum among consumers, wooden material seems to be an interesting solution to the use of other materials derived from non-renewable sources.

This return to the use of wood relies firstly on the image of tradition but also has a strong economical and ecological standpoint. Indeed, the light wooden packaging sector and more generally, 'sectors using wood as a material in contact with food' will be able to use the analytical chemistry and microbiological analysis tools validated by the partners of the consortium.

The work done on the transfer of microorganisms from surfaces to food is also very useful.

Without surprise, it has been shown that the transfer was an event quantitatively very limited for the wood material.

This original result is very important in the context of quantitative risk assessment, and even more so if you compare it in the light of research into contact surfaces for the lightweight packaging industry and for 4 types of food (oysters, apples, cheese and salads).

At first glance, the combination of these results provide strong arguments in favour of a very limited if not negligible risk of transmission of microorganisms from a wooden surface to a food.

Again, there are original findings which will be extremely useful to risk managers in the overall context of the analysis of risks defined in European Regulation 178/2002.

The analytical chemistry goal was to identify and quantify chemical components transferred from wood in direct contact with food, to assess the suitability of wood for contact with food, and evaluate this, in real temperature conditions for lightweight wooden packaging (4 and 23°C) and for 1 hour to 10 days contact time.

All the measures implemented have allowed access to two types of migration: overall migration and specific migration.

For overall migration we have seen that the molecules which migrate are mainly sugars, fatty acids and alcohols harmless to the health of the consumer.

For specific migration, 146 volatile molecules were identified and recognised harmless as they are NOT carcinogens, endocrine disrupters, nor likely molecules of bioaccumulation, nanomaterials, or radioactive substances or pharmacologically active substances.

In line with current regulations, correction factors are applied in order to minimise the extraction capacity of the food simulators. The use of correction factors has been proposed taking into account the extraction efficiency of food simulators and real wood surface in contact with the food simulator.

Overall this study helps to provide analytical data to set the limits for overall migration and the conditions for evaluating the specific migration of volatile compounds adapted to wooden material.

The EMABOIS consortium has built, on a strong scientific base, a cluster of arguments that often come in counterpoint to a priori preconceived ideas about wooden material. Indeed, it appears that for a large number of uses and with maintenance and/or usage strictly defined, monitored and controlled in a HACCP approach framework, there is no argument for the non-use of wood for food contact.

To conclude, the work achieved during these past three years allows for local level, then European level, responses to the French health authorities and the French wooden packaging sector. All tests, scientifically robust, will provide necessary elements for updating the regulations for food in contact with wood, including the DGCCRF sheet n° 2012-93 'wooden material' and will enable manufacturers of wooden packaging to have at their disposal analysis tools for reference.

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- ISMAÏL R, MICHEL V, GAY-PERRET P, AVIAT F, FEDERIGHI M. Extraction et identification de microflore d'intérêt en surface de planches d'affinage en bois d'épicéa. SFM Congress, 31 March 2014, Paris, France.
- ISMAIL R, LE BAYON I, MICHEL V, JEQUEL M, AVIAT F, KUTNIK M, FEDERIGHI M. Méthodes de récupération des micro-organismes à partir de surfaces d'emballages en bois, utilisées dans les industries agro-alimentaires. Research group « Sciences du Bois », 12-14 November 2014, Nancy, France. 1st prize for most educational poster
- LUDOSKY D, IRLE M, COPINET A, FRICOTEAUX F. Sécurité alimentaire : étude de la migration des composés organiques émis par le Peuplier lors d'un contact avec un aliment. Research group « Sciences du Bois », 12-14 November 2014, Nancy, France.
- AVIAT F, FEDERIGHI M. Le bois, source naturelle, utilisé comme emballage au contact alimentaire. Matériaux 2014, 24-26 November 2014, Montpellier, France.

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- ISMAÏL R, LE BAYON I, MICHEL V, AVIAT F, FEDERIGHI M. Le bois : matériau biosourcé apte au contact alimentaire. 4ème JTJ Interbio 2014 – SSHA, 26 June 2014, Paris, France. 1st prize for best oral communication
- LUDOSKY D, IRLE M, FRICOTEAUX F, COPINET. Wooden packaging: chemical migration between wood and food. Thèses des bois, 2 July 2014, Bordeaux, France. 1st prize for best oral communication
- AVIAT F, FEDERIGHI M. EMABOIS, un projet phare au service de l'emballage en Bois. Matériaux, 24-26 November 2014, Montpellier, France.

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- CHASSAGNEUX FX. Relecture et échanges avec AVIAT F. Le bois en contact avec les aliments. Octubre de 2014. Bois+.
- ARVISENET G, AVIAT F. Emballage bois et contact alimentaire. Nature du bois et humidité, deux facteurs influençant la migration de composés du bois vers l'aliment. Revue des Industries Alimentaires. Enero - febrero 2015 p. 25 – 27.

Other communications

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- Aviat F., Fédérighi M. 2010. Présentation du Consortium EMABois. Invitation of ANSES (Brigitte Carpentier), Paris, France.
- Brosset B, De Lagausie O. 2011. La filière Emballage Bois. Engineering School ESIReims, Reims. France.
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- Fédérighi M. 2012. Consortium EMABOIS. Conseil Régional Pays de la Loire.
- Brosset B. 2013. « Sans langue de bois » Intervention radiophonique, Nantes, France.
- Aviat F. 2013. Présentation du Consortium EMABois (sur invitation). Réunion de travail du Réseau Mixte Technologique CHLEAN, Paris. France.
- Technical journal Breizpack, St Pierre de Quiberon. Emballages, contact alimentaire et respect de l'environnement : comment comprendre ? Actualités réglementaires sur les plastiques, bois, encres et vernis. Guest speakers: FEDERIGHI M. Guide de bonnes pratiques d'hygiène : application aux matériaux. BROSSET B, de LAGAUSIE O. La filière emballage bois en France. AVIAT F. Bois au contact alimentaire : réglementation et réponses de la filière bois.
- Salon de l'emballage 2014, Paris, France. Roundtable, Web TV on 18/11/2014. Guest speakers: AVIAT F, BROSSET B, de LAGAUSIE O : Focus sur le matériau bois (emballages).

- Technical day « Filière emballages bois », Ecole Supérieure du Bois, Nantes. Guest speakers: AVIAT F, BROSSET B : Bois et contact alimentaire. Consortium EMABOIS.
- Emabois on the INRA website: M. Federighi, R. Ismaïl et F. Aviat wrote an article on the website of the laboratory UMR INRA Secalim – Oniris following the accepted publication of R. Ismaïl. The link below is accessible to all.
- http://www6.angers-nantes.inra.fr/secalim/SECALIM-a-la-une/Bois-et-contact-alimentaire
- Emabois on the website Atlanbois: http://www.atlanbois.com/s-informer/bois-et-alimentation/

Articles written for the general public

- Ludosky D., Fricoteaux F., Ghazil S., Erre D., Copinet A. 2013. Lightweight wooden packaging : Analysis of volatile organic compounds emitted from Populus and Pinus pinaster by Thermodesorption coupled to Gas Chromatography- Mass Spectrometry. Proceedings 26th IAPRI Symposium on Packaging, Espoo, Finland. Currently being printed.

9. Industrial and scientific participants

Doctoral students:

Rached Ismaïl, Microbiology doctoral student

Daliéna Ludosky, Chemistry doctoral student

Organizations

SIEL: Syndicat National des Industries de l'Emballage léger en Bois (National Union of the Lightweight Wood Packaging Industry)

Bernard Brosset, vice-president and president of the EMABOIS Consortium

Jacques Brossillon, ex-president

Michel Blanchet, president

Olivier de Lagausie, executive officer

Philippe Gallé, business leader

Philippe Samson, business leader

Hubert Villette, business leader

SEILA: Syndicat de l'Emballage Industriel (Union of Industrial Packaging)

Claude van Den Abeele, president

SYPAL: Syndicat National des Fabricants de Palettes en Bois (Commission of the National Federation of Wood Pallet Manufacturers)

Jean-Marie Tanguy, executive officer

GROW, Group Recycling of Wood:

Thierry Péré, president of the European Packaging Network

For interprofession: France Bois Forêt

Dominique Juillot, ex-president

Laurent Denormandie, ex-president

Jean-Emmanuel Hermès, director general

Scientists

28 scientists along with two doctoral students

Actalia Produits Laitiers (Actalia Dairy Products)

Valérie Michel, leader of the dairy microbiology division, co-supervisor of the thesis

Perrine Gay-Perret, technological engineer

Sylvie Engelmann, research technician

Michel Nedellec, technology advisor

Eric Notz, project chief

ESB Ecole Supérieure du Bois (Wood Science and Engineering Institute)

Arnaud Godevin, school director

Mark Irle, Research director, co-supervisor of the thesis

Stéphane Belloncle, lecturer

Salouah Gazil, professor

ESIReims: Ecole Supérieure d'Ingénieurs en Emballage et Conditionnement (Higher Engineering School for Packing and Packaging)

Damien Erre, School director and co-director of the thesis

Alain Copinet, Research lead, co-director of the thesis

Florence Fricoteaux, Lecturer, co-director of the thesis

Jean-Baptiste Nolot, study engineer

Nathalie Choiselle, research technician

FCBA: Institut Technologique Forêt Cellulose Bois construction Ameublement (Technological Institute of Forest Wood Cellulose Furniture)

Marc Jequel, directory of laboratories division FCBA Bordeaux

Magdalena Kutnik, biology laboratory directory

Isabelle Le Bayon, technical manager, co-supervisor of the thesis

Mathilde Montibus, project chief

Martine Gabille, research technician

Adeline Jasick, research technician

Melissa Prégnac, research technician

Oniris: École nationale vétérinaire, agroalimentaire et de l'alimentation, Nantes-Atlantique (Nantes Atlantic National College of Veterinary Medicine, Food Science and Engineering)

Michel Federighi, director research department AlimScan, director of the thesis

Florence Aviat, EMABOIS project chief

Valérie Anthoine, research technician

Albert Rossero, study engineer

Gaëlle Arvisenet, lecturer

Laurent Lethuaut, lecturer

Laurence Dubreuil, study engineer

Members of the thesis monitoring committee

Microbiology thesis monitoring committee

Anne-Marie Riquet, INRA Agroparistech

Sylvie Lortal, INRA Rennes

Chemistry thesis monitoring committee

Gaëlle Arvisenet, AgrosupDijon

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