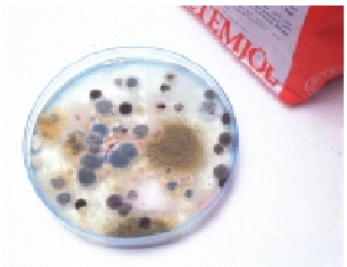
Nordisk Industrifond
senter for innovasjon og næringsutvikling

- Nordic Wood 2

Wood in the Food Industry



DANISH TECHNOLOGICAL INSTITUTE

Trätek

Icelandic Fisheries Laboratories

Fiskeriforskning

Background

Wood has been a traditional material for many applications in the food industry. But today wood is getting discriminated in many sectors of the food industry - both in utensils, interiors, and buildings as well as in pallets and packaging. The reasons stated are

- wood is less hygienic
- is a porous material
- risk of splinters
- lack of cleaning or sanitation methods

The legislation in the European countries is very similar, and based on The Hygiene Directive. However, the interpretation seems to be different in different countries. For example the interpretation of the legislation has caused a lot of problems and costs for the fisheries in the Nordic countries, especially in Iceland and Norway. In buildings for fisheries pure wood is no longer permitted and should be replaced or covered with a material that is resistant and easy to clean which is interpreted as a non porous surface.

Some countries are now facing a situation where the food industry is coming up with new and more severe requirements regarding the use of wood. This is not only concerning pallets and packaging even if these products often are affected first, but also the use of wood in utensils, furniture, buildings and interiors.

Exclusion of wood used in the food industry is unfortunately not based on scientific documentation but merely on assumptions. In order to get more knowledge and a fair base for decisions studies have been carried out and are still ongoing in several European countries e.g. in Germany, Switzerland and the Nordic countries. This folder is a result of a 4 year Nordic project and with results from other studies included.

Both laboratory testing and field tests of the hygienic properties of wood have been carried out. In order to get a frame of references the tests have often been carried out as a comparison between materials.

Conclusion

There are many studies on the hygienic properties of wood. In both recent and previous studies the results confirm that wood is as good as other materials to use in the food industry - in utensils, interiors, and buildings as well as in pallets and packaging.

- Wood is as hygienic as any other material for most applications in the food industry.
- The porosity of wood doesn't seem to be a negative factor.
- There are cleaning/sanitising methods suitable for wood.

Good manufacturing quality, good handling practice and proper sanitation treatments surely make wood a suitable material for most applications in the food industries.

The legislators are requested to study the results in order to review and amend regulations and laws, in which the use of wooden materials is prohibited.

Results from Testing

This leaflet gives a short summary of the latest studies. The studies have been performed in the Nordic countries as a Nordic Industrial Fund project "Wood in the Food Industry" and in Germany and Switzerland.

Studies of bacteria have been carried out in the food industry on interiors, buildings and pallets. Also laboratory tests were carried out on wood and other materials that were contaminated by bacteria.

Wood in constructions

Gluelam is a wooden product often used in constructions and therefore studies were performed on gluelam.

The hygienic properties of differently treated gluelam and galvanized steel, used as a construction material in the food industry, were studied under three different conditions:

- in a saltfish warehouse (temperature -2 to +3°C and relative humidity RH >80%),
- in a caviar processing hall (temperature 16-18°C and RH 60-80%)
- varying climates where samples were moved between different places every 4th day during one month - high and low temperature (0-15°C) and high and low relative humidity (20-80%).

Figure 1-3 show results from tests with the following treatments:

- *1A is treated once with Kopal primer (water based) and twice with Kopal acrylic painting (water based)*
- *1B: twice with Kopal epoxy painting (water based)*
- *2A: twice with Parquet painting (water based);*
- *3B: twice with Epoxy painting (oil based)*
- *4A: twice with Kjörvari 14 (wood preservative surface treatment);*
- *5: untreated gluelam and*
- *6: galvanised steel*

The results from samples taken in a saltfish warehouse are shown in figure 1 and from a caviar processing plant in figure 2.

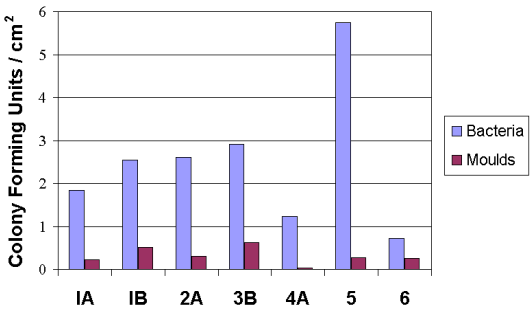


Figure 1. Number of bacteria (average number from 8 surveys) on different treated glulam and stainless steel after 16 months in wet and cold environment (0-3°C and >80%RH).

The results are very good and the total count on the gluelam samples was below 5 CFU/cm^2 for the first 8 month. The count of mould and yeast was below 1 CFU/cm^2 during the 16 months while the experiment where running. The untreated control sample shows however higher number compared with treated samples. From these results we can conclude that gluelam is as good regarding hygienic properties for the use of wood in constructions in cold and wet environment. /Report no 8,9/

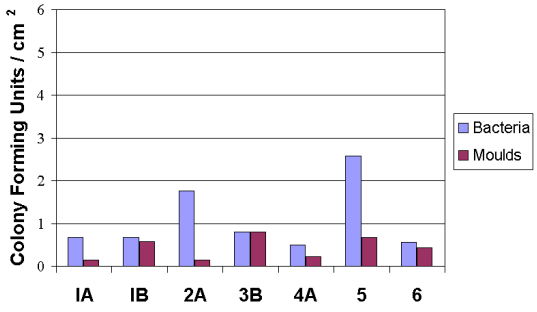


Figure 2. Number of micro-organisms on differently treated glulam in caviar processing factory during 10 month. The temperature was 16-18°C and the relative humidity 60-80%.

The results from the caviar processing factory are similar to the results obtained in the saltfish industry.

The results from microbiological tests at different humidity are shown in figures 3.

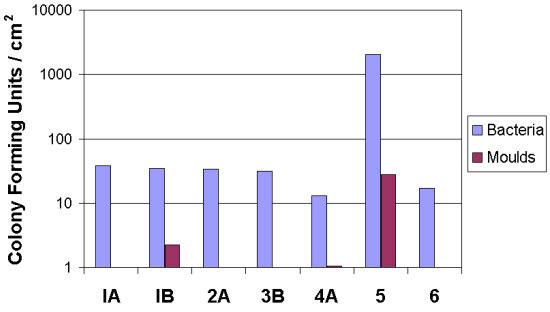


Figure 3. Number of micro-organisms on differently treated glulam moving between different climatic conditions.

This study supports the conclusion made by Worfel et al, (1995)/3/that material used in construction of food production plants is not as important as other factors like avoiding the condensates and that cleaning is important for all types of material.

Wood in Pallets and Packaging

Pallets and packaging are used for protection, handling and storage of goods. The food distribution chain is one important user of pallets and packaging. Wood has been a traditional material for pallets and packaging. In many food sectors wooden pallets and packaging are now replaced by plastic pallets under the assumption that these are more hygienic and easy to clean. Therefore, wooden pallets have been tested and compared with plastic pallets in order to have some reference figures.

The German Institute for Food Technology carried out field tests in 14 companies - in the meat, dairy, vegetable and bakery sectors - with commercial wooden pallet, a special treated hygiene wood pallet (not described here) and plastic pallets. The results from the different food sectors and in total (15,000 measurements) are shown in figure 4 and 5.

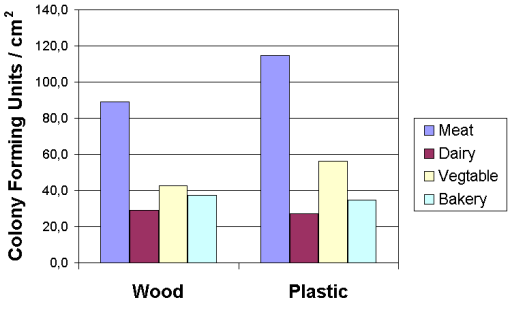


Figure 4. Bacterial count - A comparison of, wood pallets and plastic pallets in the meat, dairy, vegetable and bakery sector.

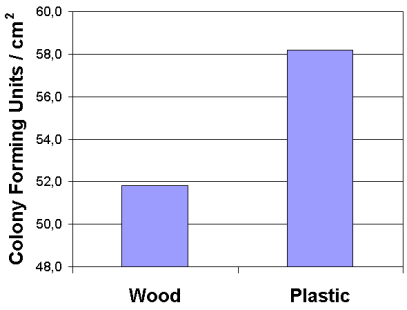


Figure 5. Bacterial count on wood pallets and plastic pallets (mean values of total number of measurements).

The overall bacterial count on commercial wooden pallets made from different types of wood was on average 15 % lower than on plastic pallets. /5/.

From the German studies there seem to be evidence that pine and especially heartwood of pine is superior to other frequently used species. Beside the hygroscopic properties of wood the high content of extractives in certain species e.g. pine proved to have a good antibacterial effect /4,5/.

In the Nordic project the pallet studies were performed in a saltfish warehouse, a super market and a dairy. Six different types of wooden pallets and two types of plastic pallets were tested – an Icelandic Polyethylene (PE) pallet with a solid deck and a French High Density Polyethylene (HD-PE) pallet. /Report no 8 and 9/

Figure 6 and 7 show the number of bacteria on wood and plastic pallets used in the food industry

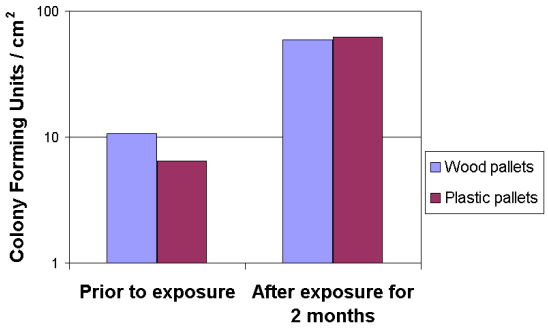


Figure 6. Average amount of bacteria per cm^2 on wood pallets and plastic pallets respectively prior to exposure and after exposure for 2 months to salted fish. The pallets have been stored and used in a humid and cold environment (85% RH and 0-3^{o}C.)

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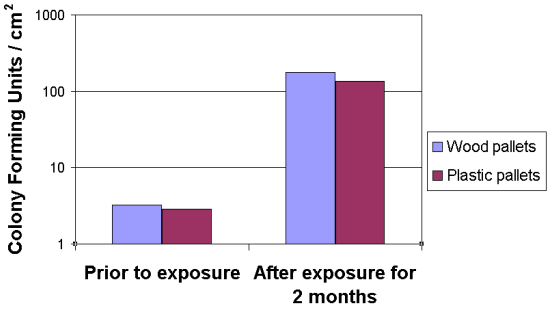

Figure 7. Average amount of bacteria per cm^2 on wood and plastic pallets respectively prior to exposure and after exposure for 2 months in the distribution chain for supermarkets. The pallets have been stored and used in a dry and warm environment (28% RH and 16^{o}C)

Laboratory Tests

The aim of the laboratory test of the Nordic projects was to test the survival of selected bacteria *(Bacillus subtilis* and *Pseudomonas fluorescens)*, commonly found in the meat industry, under different conditions. The project includes testing of planed beech, oak and ash, because these wood species are used as tabletops in general or in production lines and as interior fixtures, handles, cutting-boards etc. For the packaging industry it was decided to test sawn, untreated sapwood of pine and spruce. Stainless steel and plastic were used as reference materials. /Report no 10/

Beneath some results from laboratory tests are stated; in these tests different wood species as well as plastic and steel are inoculated with bacteria.

The results in figure 8 reflect the number of bacteria on surfaces that are in direct contact with meat e.g. chopping boards, tabletops, handles of a knives etc.

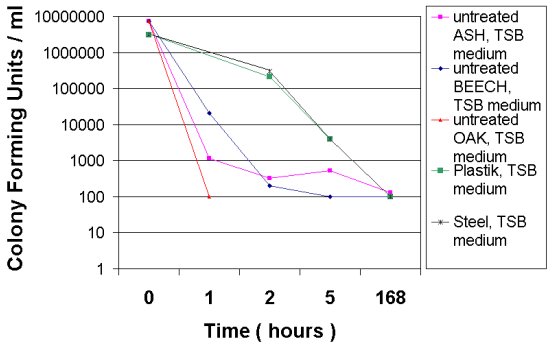

Figure 8. Ash, beech, oak, plastic and steel inoculated with bacteria. It was measured how long the bacteria can survive on the different materials. The wood test specimens were made of planed wood.

It can be seen that different wood species give different conditions of life for bacteria. Generally, it has been shown that oak does better compared with beech and ash.

Figure 9 shows that Scotch pine for pallets is a more hygienic wood species to use compared with Norway spruce.

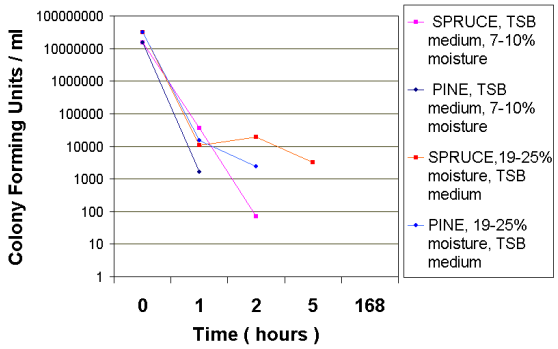

Figure 9. Untreated Scotch pine and Norway spruce inoculated with bacteria on 2 wood moisture levels. The test specimens were of planed wood.

Not only the wood species but also the wood moisture is decisive for the extent of hygiene in connection with food. Increasing wood moisture implies better conditions of life for bacteria.

Tests on linseed oil treated wood showed that linseed oil did not make a considerable difference. See figure 10.

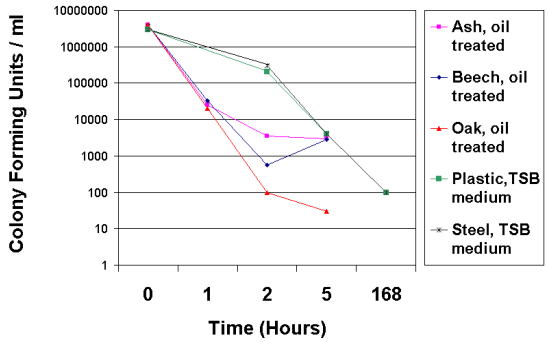

Figure 10. Linseed oil treated Ash, Beech, Oak, Plastic and Steel. The wood test specimens were of planed wood.

Also tests were carried out on new and artificially aged wood. The results showed only slight difference between new and artificially aged samples. /Report no 10/

The survival of bacteria (E.Coli) on different wood species, polyethylene, steel and glass were also compared in German laboratory tests. There overall conclusions were about the same as in the Nordic study. In addition it was also proved that bacteria didn't survive within the wood. /4/.

Cleaning and Sanitising Treatments

Cleaning shall remove microbes or materials that can cause contamination or be a potential site of pests.

Packaging and packaging materials are factors to consider and control in order to minimise contamination (physical, chemical and microbiologic) of the food.

Common cleaning methods are manual cleaning, water rinsing, high-pressure water treatment, foam cleaning, steam or automatic machines. There are many types of cleansers and disinfectants dependent on materials, types of contaminants or microbes. The criteria for materials and surfaces are often that the materials shall not be toxic or absorbing but resistant to detergents.

For wooden pallets and packaging there are some methods to consider and then the possibilities for using wood are much better.

Cleaning

High pressure water rinsing is a cheap and efficient method and can efficiently remove dirt as well as bacteria, which can be seen from the Nordic study in the field tests., see Figure 11 showing cleaning with high-pressure cold water Microorganisms were not detected on the wooden pallets after cleaning. The pallets were stored in a saltfish warehouse for two months in a wet and cold environment prior to cleaning. /Report no 8,9/

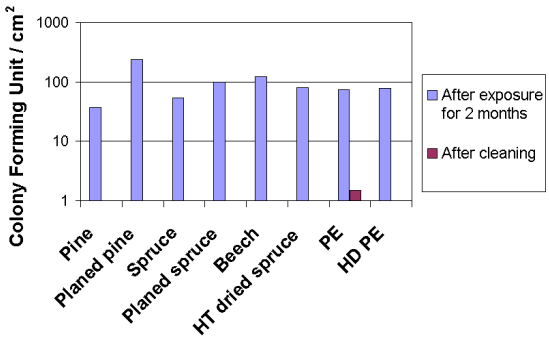

Figure 11. Effect of cleaning wood and plastic pallets using high-pressure (180 bar) and cold-water treatment. Mean value from two surveys

According to Icelandic guidelines for surfaces in direct contact with food this is acceptable. The limit for "acceptable" is 5 CFU/cm^2 or below.
Another possibility to remove dirt is to use steel brushing

Laboratory Test with Cleaning after Contamination

Cleaning after contamination of plastic and wood with normal detergent without antibacterial additives is effective. /Report no 10/

The conclusion of the laboratory test in the Nordic project was:

- Bacterial survival is the lowest on wood.
- Bacterial survival is lower on planed oak compared to beech and ash.
- For pallets, sawn pine is performing better than spruce both at high and low moisture content and with both test bacteria.

- Oil treatment with linseed oil does not improve the wooden product with regard to hygienic properties
- Artificial ageing does not change the overall conclusions on the hygienic properties of wood, plastic and steel.

In the Swiss study the hygienic aspects of cutting boards made of wood (European maple, beech and oak) and polyethylene (PE) were compared in order to determine the risk of food contamination in households and commercial kitchens. The cutting boards were infected and the colony forming units were measured before and after machine and manual washing

The results showed that in very humid environments both wood and PE showed very high numbers of bacteria even after washing. Probably the high surface moisture led to ideal conditions for microorganisms. In drier environments, significantly less bacteria were retrieved on wood than on PE. The effect is not clearly established but it was observed that the porous surface of wood dries out faster.

A significant decrease of bacterial count was found after manual washing with detergent and brush followed by rinsing under warm water. /6/

The overall conclusion is that wood is just as easy to clean and is an acceptable hygienic material.

Sanitising

The pallets and other wooden products can be pasteurised by using

- Heat treatment by adding an additional drying cycle in a kiln
- High temperature treatment – High temperature kilns 110-115 °C
- Radiation, i. e gamma rays.
- Microwave technology.

A microwave process has been developed for sanitising wooden pallets and corrugated boxes for eggs in order to prevent poultry pathogens to be transferred from one production site to another. The killing effect on 10^6 CFU of *Serratia marescens*, an indicator bacteria simulating Salmonella, has been validated both on egg trays and EUR-pallets. The tests have been performed with moisture content of 25 % for the EUR-pallets /Rapport 8/

Wood samples of pine and beech infected with bacteria (*Bacillus subtilis* and *Enterococcus faecalis)* and samples of mould infected panel material have also been tested. The numbers were reduced radically but not totally. The results indicate there is a good reason to continue to make series of tests to find out the right process for different types of microorganisms. /report no 8, 10/

However different species and different treatments of the pallets might be necessary for different hygienic requirements. Ongoing studies will give more information.

Classification of flavourings

The migration of substances from different materials into food is yet another highly debated subject. For toxicological risk assessments for different wood species that can come into contact with food there is a classification system for the wood and/or the bark of different species.

Before 1992, The Council of Europe used a classification system (N1-N4) in the assessment of natural source materials for flavourings, which was published in the “Blue Book”. In the new assessments, the classifications use six categories.

E.g. oak is categorised as 2, which is: *Plants, animals and other organisms and parts of these or products thereof, and preparations derived thereof not normally consumed as food items, herbs or spices in Europe.*

These source materials and preparations, on the basis of the information available, are not considered to constitute a risk to health in the quantities used

Pine and beech are categorised as N3, which is: *Plants, animals and other organisms and parts of these or products thereof normally consumed as food items, herbs or spices in Europe which contain defined active principles or other chemical components requiring limits on use levels.*

These source materials and preparations are not considered to constitute a risk to health in the quantities used provided that the limits set for active principles or other chemical components are not exceeded.

More details are available from the Council of Europe, www.Coe.fr, under Partial Agreement or Health Committee

Reports and references

The reports, 1-10, are obtainable as pdf. files on web-sites of the RD participants

Report No 1. Literature review on the suitability of materials used in the food industry, involving direct or indirect contact with food products.

Report No 2 Wood in food. Measuring methods (to control the hygienic status of wood in the food industry)

Report No 3 Legislation on foodstuffs.

Report No 4 In Danish. Spörgeskemaundersökelse vedrörende brug af trä i Norden til levnedsmiddelformål.

Report No 5 Short report from a pilot study regarding wood treatments and hygienic properties of wood.

Report No 6 Hygienic limits and cleaning procedures.

Report No 7 Wood, waxed wood, plywood, polyethylene and stainless steel - a comparison of hygienic properties.

Report No 8 Wood in the food industry - guidelines for handling wooden pallets and packaging.

Report No 9 Hygienic properties of wood – Field studies on wooden pallets and wooden constructions.

Report No 10 Wood, plastic and steel – a comparison of hygienic properties.

/3/Worfel, R.C., Sofos, J.N., Smith, G.C., Morgan, J.B. and Schmidt, G.R. (1995). Microbial Contamination of Condensates Formed on Superstructure of Wood and Other Materials in Meat Plants. Dairy, Food and Environemntal sanitation, Vol. 15, No. 7, Pages 430-434.

/4/ A. Schönwälder*, R.Kehr**, A.Wulf**, K Smalla*: Antibakterielle Eigenschaften von Holz beachtenswert Holz-Zentrallblatt, December 8, 2000.

Biologische Bundesanstalt für Land-und Forstwirtschaft, *Institut für Planzenvirologie, Mikrobiologie und biologische Sicherheit und **Institut für Planzenschutz in Forst, Braunschweig, Germany

/5/ H.Steinkamp*, H.Wilms** Untersuchungen zur Einführung von Hygiene-Palleten aus Holz zum Einsatz in der Lebensmittelindustrie. Das Forschungsprojekt wurde gefördert durch das Niedersächsische Ministerium für Wirtschaft, Technologie und Verkehr.

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http://www.wilms.com/Hygiene/default.asp

/6/ M.Gehrig, G.Schnell*, E. Zürcher, L.J.Kucera: Hygienische Eigenschaften von Holz- und Kunststoffbrettern in der Nahrungsmittelverarbeitung und -präsentation. Ein Vergleich. Holz als Roh-und Werkstoff 58 (2000) 265-269. Springer Verlag

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