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- Nordic Wood 2

Project P 98131 "Wood in the Food Industry"

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Wood in the food industry - guidelines for handling wooden pallets and packaging

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Foreword

Wood used to be the most common material for packaging, workbenches, shelves, tools, buildings, interiors etc., in the food industry in the Nordic countries. The use of wood has however decreased, and other materials like plastic, concrete, stainless steel and aluminium have taken its place. The reason for this negative development seems to be declining market demands, partly caused by legislation in Europe and elsewhere.

Despite this, nearly 1,5 million cubic meter of timber per year is used for pallets and packaging in the Nordic countries. These products are hence of great importance for the wood industry as the alternative production of packaging materials may be chips for pulp production. Based on that background, a Nordic research project was initiated to find out more about the behaviour of wood in contact with foodstuff.

The main object of the project has been to find out basic facts about the hygienic properties of wood and collect data regarding wood products and their substitutes when used in the food industry.

This report is one in a series of reports where the results from the Nordic Wood 2 project no. P 98141 ”Wood in the Food Industry” are presented.

This part report gives information about Hazard Analysis and Critical Control Points and Good manufacturing practice, guidelines for handling, cleaning and sanitation of wooden pallets and packaging.

The project is funded by the Nordic Industrial Fund through their program Nordic Wood 2 which is an R&D program for the Nordic wood industry. The Nordic timber and woodworking industry and national funding authorities in the Nordic countries have raised additional funding.

The project has a steering group with the following members:

- Dag Aasheim, chairperson	Otta Sag&Høvleri AS
- Peter Jensen	Dansk træemballage AS, Denmark
- Stefan Nilsson	Åsljunga Pallen AB, Sweden
- Bjarni Ingibergsson	Limtré h.f., Iceland

The research is carried out by The Danish Institute for Technology, Icelandic Fisheries Laboratories, The Norwegian Institute for Wood Technology, The Norwegian Institute for Fisheries and Aquaculture and The Swedish Institute for Wood Technology Research. Representatives from food surveillance institutions in the Nordic countries are invited to the project meetings. Pallet manufacturers, sawmills, woodworking industries and users of wooden constructions, pallets and packaging are also involved.

The participants would like to forward their warm thanks to Nordic Industrial Fund and the national funding authorities in Denmark, Iceland, Norway and Sweden that have contributed to the funding of the project.

This part report no. 8 is written by: **Gunilla Beyer**, Swedish Institute for Wood Technology Research
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Stockholm January, 2002

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Table of contents

Summary

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

- risk of splinters
- wood is a porous material
- lack of cleaning and/or sanitation methods

Since 1998 a Nordic project is going on with the aim to find out basic facts about the hygienic properties of wood. This report will give some information about Hazard Analysis and Critical Control Points (HACCP) and Good Manufacturing Practices (GMP), some general guidance for handling wooden pallets and packaging in the food industry and information about some methods for cleaning and sanitation in order that wooden pallets and packaging can be used in the best way.

Recent studies both in the Nordic countries and in Europe have shown that wood is as good as any other material for many purposes in contact with food.

In order to keep a good hygiene there are some general rules for handling and storage of pallets and packaging.

Use clean, dry pallets for the food industry. Wooden pallets should not be stored unprotected outdoors in order to avoid biological, physical and chemical contamination.

Keep pallets separated – special pallets for hygienic zones

Use pallet inverters. To avoid contamination a possible, cheap and easy solution is to use wooden pallets with a slip-sheet on top. When depalletising one pallet the receiving pallet also has a slip-sheet on top. The pallets can be kept in separate zones and the slip-sheets can be made of different materials, expendable or reusable.

One method to clean pallets is to use high pressure water sprinkling.

The pallets can be pasteurised by using

- Heat treatment by adding an additional drying cycle in a kiln
- High temperature treatment
- Microwave technology, which seem to be one very promising method. This method is used in the egg industry but need to be adjusted for other food sectors

Wood in the food industry

– Guidelines for handling wooden pallets and packaging

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

- risk of splinters
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- lack of cleaning and/or sanitation methods

Since 1998 a Nordic project is going on with the aim to find out basic facts about the hygienic properties of wood. This report will give

- information about Hazard Analysis and Critical Control Points (HACCP) and Good Manufacturing Practices (GMP)
- some general guidance for handling wooden pallets and packaging in the food industry
- information about some methods for cleaning and sanitation

Wood in the food industry

The reason for the negative attitude towards wood seems to be caused by the food legislation and the interpretation thereof in Europe and elsewhere.

For many purposes hardwood is however accepted in contact with food. As an example, beech is used for ice cream sticks. Here the wood must be strong, feel good in the mouth and not give any flavour to the ice cream. In addition, the wooden stick is isolating and prevents the ice cream to melt too fast. Beech is also frequently used in cutting boards and kitchen utensils.

In the American regulations hard maple or an equivalently hard, close-grained wood may be used for cutting boards, cutting blocks, bakers tables and utensils such as rolling pins, doughnut dowels, salad bowls and chopsticks /1/.

There are many studies on the hygienic properties of wood, see report 1 /2/. In some recent studies there are new results supporting that wood is not less hygienic than other materials.

In a 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 household and commercial kitchen. The cutting boards were infected with *Escherichia coli (E.coli)* and the colony forming units were retrieved by agar contact methods before and after machine and manual washing. Results showed that in very humid environment 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 environment, 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 than the PE surface. Scanning electron microscopy showed that the surface of the PE boards obtained a very rough and cavernous surface after a month of intensive use. On wood these surfaces dry out quicker. A significant decrease of bacterial count was found after manual washing with

detergent and brush followed by rinsing under warm water. The conclusion was that the results of the experiments showed that wood is not less hygienic than PE /3/.

Two scientific studies in Germany /4, 5/also showed that certain types of wood were more hygienic than plastics. In one study the survival of *E.coli* on different wood species and PE were compared. When an equal number of bacteria are applied to different wood species the number are reduced and the speed is depending on the species. The best effect was achieved on pine. The number of bacteria were not only reduced on the surface but also to the same extent within the wood itself /4/. The outcome of these studies were checked in field tests. The German Institute for Food Technology carried out tests in 14 companies - in the meat, dairy, vegetable and bakery sectors - with commercial wooden pallets, special hygiene wooden pallets and plastic pallets. The hygiene pallet was made of pine using a special drying method (patent pending). The results from the different food sectors and in total (15 000 measurements) are shown in figure 1 and in figure 2.

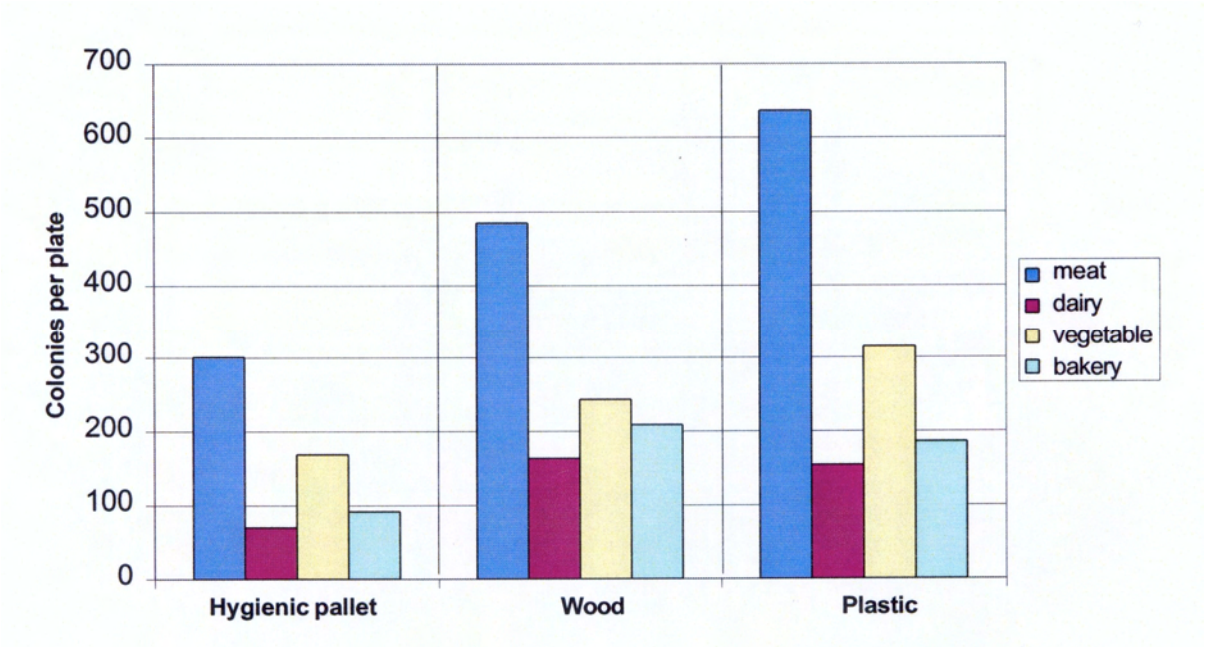


Figure 1 Bacterial count per plate - A comparison of hygiene pallets, wood pallets and plastic pallets in the meat, dairy, vegetable and bakery sector.

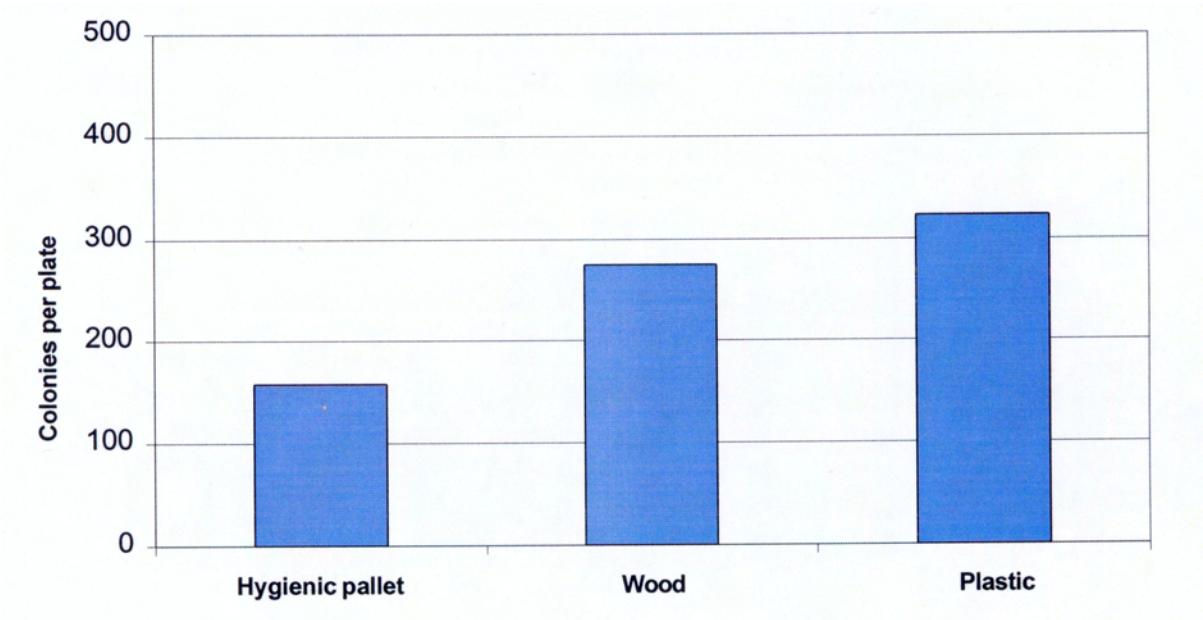


Figure 2. Bacterial count on hygiene pallets, wood pallets and plastic pallets (mean values).

The overall bacterial count on commercial wooden pallets made from different types of wood was on average 15 % lower than on plastic pallets. The bacterial count on hygiene pallets made of pine heartwood was on average only half the number compared to 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. And the special heat-treated hygiene pallets were superior to untreated pine pallets. Beside the hygroscopic properties of wood the high content of extractives in certain species e.g. pine proved to have a good antibacterial effect. Temperature, moisture content and number of bacteria at infection were other factors that affected the survival of bacteria. There was also a difference between different bacteria. The gram-positive *Enterococcus faecium* could survive longer than the gram-negative *E. coli* on wood; the survival on plastic were longer than on wood /4/. Additional ongoing studies in Germany are soon going to be published.

In the Nordic project field tests are also going on in different sectors of the food industry. Different wooden pallets (made of spruce, pine and beech) as well as gluelam (used in constructions) with different coatings are tested and compared with other materials such as polyethylene (PE) and stainless steel. These results will be published in a separate report but some preliminary results are shown in this report in figures 3-6.

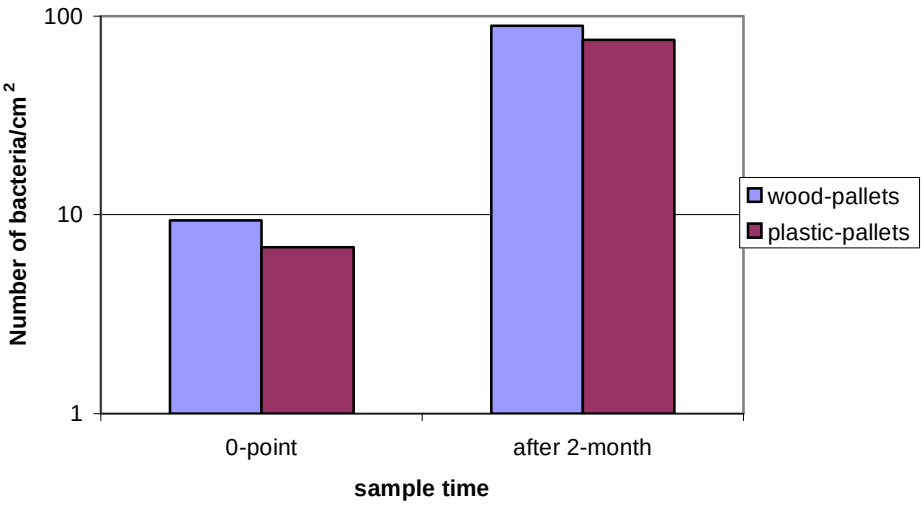


Figure 3. Bacterial count on wood pallets and plastic pallets (mean values) after 2 months in wet and cold environment.

The results from a microbiological survey on wood and plastic pallets are shown in figure 3 and 4. Figure 3 shows results from pallets which were loaded with saltfish and kept for two months in wet (85%RH) and cold environment (0-3°C). The difference in number of bacteria on wood and plastic pallets is a minimum with slightly less bacteria on plastic pallets. Figure 4 shows similar results from pallets kept in the distribution chain in one supermarket in Iceland. The environment was dry (28% RH) and warm (16°C). The number of bacteria were slightly less on the plastic pallets (PE) and High Density PE (HDPE).

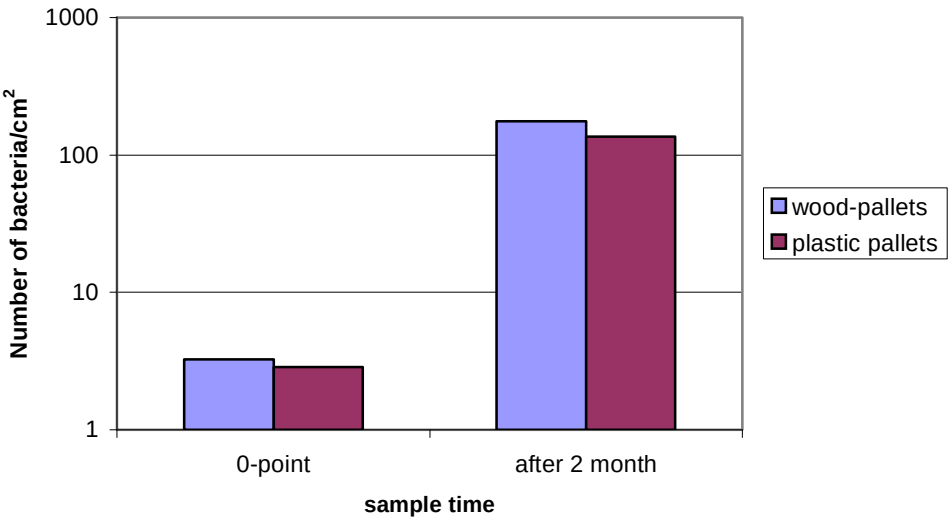


Figure 4. Bacterial count on wood pallets and plastic pallets (mean values) after 2 months in dry and warm environment.

Figure 5 and 6 show results from samples of gluelam. A set of samples with different coatings were placed in the same warehouse as the pallets in figure 3, wet and cold environment. 1A is painted once with acryl primer (water based) and twice with acryl painting, 1B twice with epoxy painting (water based), 2A twice with polyurethane/acrylic lacquer (water based), 3B twice with epoxy painting (oil based) and 4A twice with decay prevention (wood preservation surface treatment). As control samples untreated gluelam and stainless steel were used. Microbiological samples were taken every second month during 16 months. The samples were evaluated both for total number of bacteria and for the growth of mould and yeast. Mould and yeast were very seldom identified and those results are not presented here. The figure 5 and 6 show that the number of bacteria depend more on the time when the samples were taken then on different coatings. The untreated control sample shows however higher number compared with treated samples and with the fewest for stainless steel.

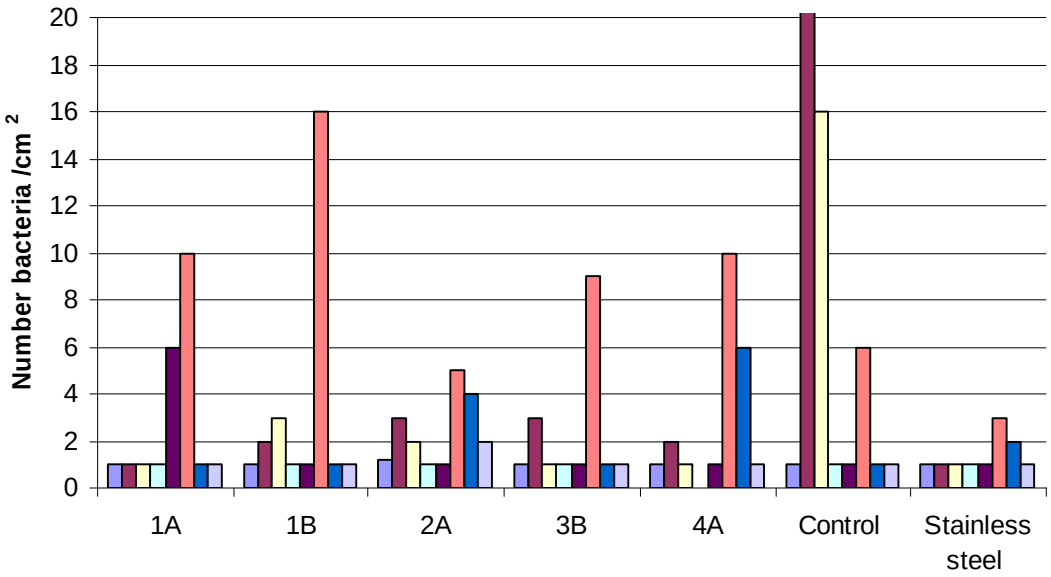


Figure 5. Bacterial count on different treated gluelam and stainless steel after 16 months in wet and cold environment.

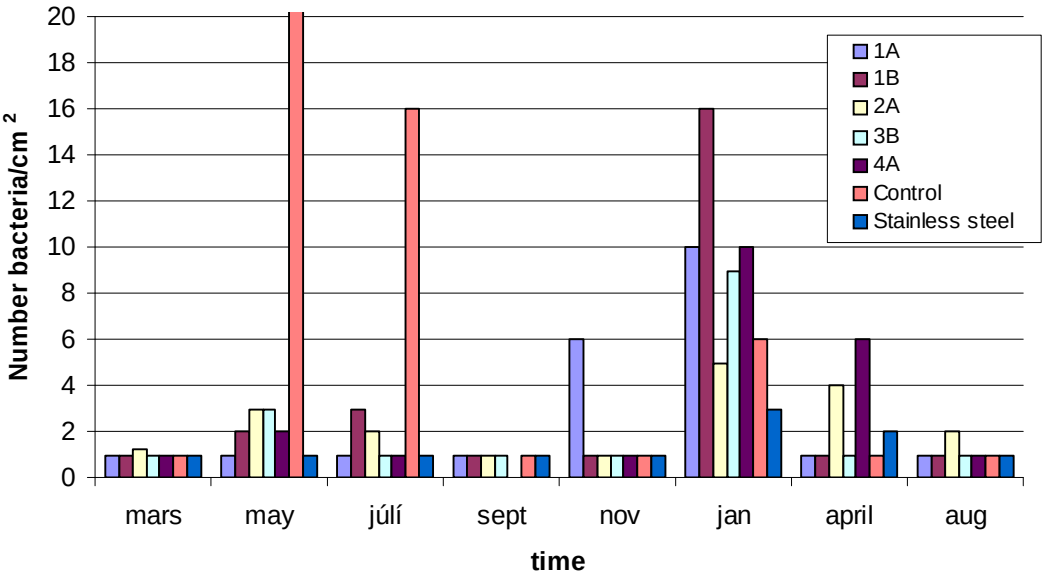


Figure 6. Bacterial count at different time on treated gluelam samples and stainless steel in wet and cold environment.

But still all the counts are very low and these samples are not in direct contact with food. From these results we can conclude that gluelam is as good as stainless steel regarding microbiological contamination for the use of wood in constructions under these conditions.

In order to use wood in the food industry there are however some aspects to consider. For different sectors with exposure to various types of bacteria different solutions could be needed. Different species and different treatments of the pallets might be necessary for different hygienic requirements.

Pallets and wooden packaging, such as light packaging for fruit and vegetables are made of different species. In the Nordic countries pallets and wooden packaging are predominantly made of our softwood species spruce and pine.

The following chapter will describe the main principles in the regulations to prevent contamination of food and make special notice on items regarding wooden pallets and packaging.

Food Hygiene

General requirements

The food producers have their regulations, routines and control systems to ensure a safe production. These are mainly preventive measures such as personal hygiene, selection of materials, food preparation and cleaning procedures. Nutrition, humidity, temperature, pH and aerobic (or sometimes anaerobic) conditions affect the growth of microorganisms that can destroy or infect food. As an example the following is a summary of some general hygienic requirements concerning storage and transportation from one food producer /6/.

- The food shall not be stored together with substances, products or utensils that can harm the food.
- The storage should be under clean and closed conditions to avoid mice, insects etc.
- The transportation equipment - conveyors, lifting trucks, stacking equipment etc - need regular cleaning and service.
- Transport boxes and crates shall be clean.
- During transportation the food shall be protected by sealed packaging.
- Avoid contamination by not using loose parts for temporary repair.
- Wooden pallets in the food production shall be clean and in good condition without any damage. If the pallets are dirty or contaminated these shall be removed. In the hygienic zone wooden pallets are never used.

In addition there are often other requirements like modular sizes of pallets and packaging for more efficient handling /7/.

HACCP - Hazard Analysis and Critical Control Points

The food industry needs to identify hazards and critical control points in the production. These hazards could be of biological, chemical and physical nature. This chapter will shortly

describe the main principles in HACCP. There are different systems for HACCP and hygiene certification but these are covering about the same items /8, 9/.

In Denmark there is also a standard, DS 3027 /10/, for food safety. Companies which produce, handle, supply or deliver food products recognise a need to demonstrate and document a control system with regard to food safety. This also applies to their subcontractors. The standard describes the elements of a quality system based on HACCP principles. There is an attempt to make this a European standard.

The standard describes the key requirements for a quality system, which enable the company to formulate food safety policies and objectives according to HACCP principles. The standard is intended to be used in connection with product development and manufacturing within the food industry. The standard can be applied within all sectors of the food industry - distributors and transport companies, suppliers of packaging, equipment, raw materials and other accessories to the food industry. The standard can be used by all companies wishing to establish a HACCP system for food safety.

The standard contains

Definitions for control, monitoring, validation and verification

HACCP System requirements

- Management responsibility
- System requirements
- Document control
- HACCP study and planning with descriptions of raw materials and each product/ product category, intended use of the product, flow diagram, identification of hazards, establishment of control measures, critical control points, critical limits, monitoring systems etc
- Operation of the HACCP system
- Maintaining the HACCP system

The product description shall include a description of raw materials; chemical, biological and physical characteristics; origin; delivery method; packaging and storage conditions; preparation before use. The description of each product/product category shall include raw materials used; chemical, biological and physical characteristics; storage and distribution conditions.

Criteria for traceability of each material or product in contact with food are now under evaluation in Europe.

HACCP is aiming at securing a high safety level in the production/food processing industry. HACCP must be based on routines for Quality Assurance and a hygienic environment at production.

Good Manufacturing Practices (GMP)

HACCP is a requirement and GMP give guidance to assure product quality and safe processing environment. GMP provide supporting routine control points for important areas such as

- Incoming raw materials and outgoing products/articles
- Processing
- Quality control, test methods and documentation
- Control and elimination of pests
- Hygienic design and maintenance
- Cleaning and disinfection
- Policies and education

Regarding the industry premises for food processing the following points are mentioned in the food legislation

The construction, design, equipment and interiors of the food premises shall

- protect against accumulation of dirt, toxic materials, debris, undesired mould etc
- prevent cross contamination
- prevent pest contamination e g from vermin

Pest control

Pest control is a legal requirement for every food business and aims to prevent the contamination of food and the spread of disease. Prevention of contamination requires either removing the source or putting a barrier between the source and the food. By adopting a concept of IPM (Integrated Pest Management) which include eliminating pests or preventing pests from entering a building it's possible to attain Good Manufacturing Practices (GMP).

IPM is a decision making process which requires

- Proper identification of the pest(s) or damage caused by the pest and location of the infestation(s) through inspections and monitoring.
- Specification of tolerance levels for pests
- Application of IPM strategies to solve the problem
- Verification that the IPM process is functioning

According to Holmberg and Walling /11/ IPM may be linked with HACCP as shown in figure **7.**

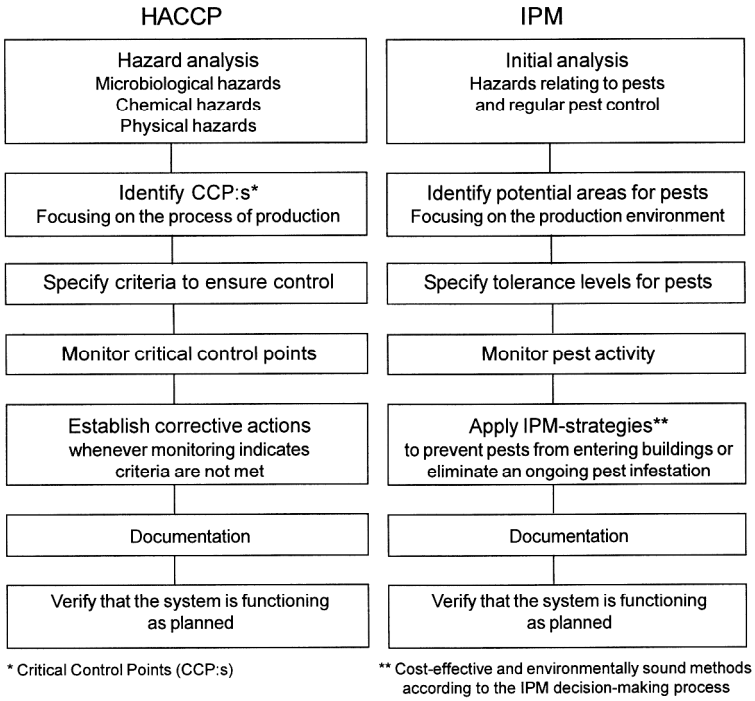


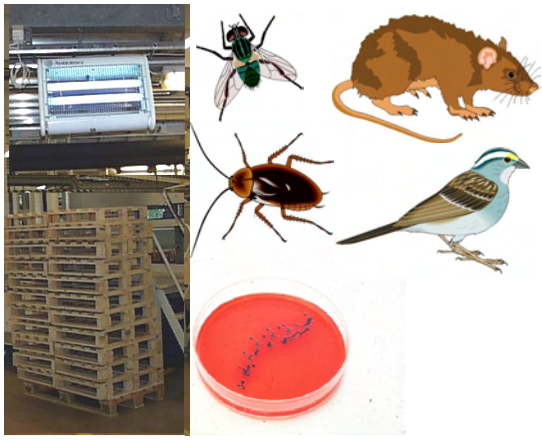
Figure 7. The HACCP-principles linked to IPM /11/.

In order to keep a good hygiene there are some rules for handling and storage of pallets and packaging.

Hygiene aspects on wooden pallets and packaging in the food industry

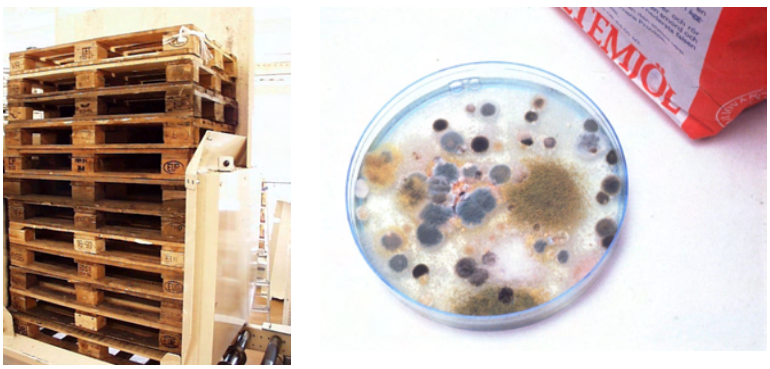
Pallets, cases, cardboard boxes, trays, sacs etc shall be stored to prevent contamination and facilitate cleaning.

Pallet can during outside storage be contaminated. Birds, rats, mice and highly mobile insects are example of possible sources for contamination or transmission of microorganisms. Clean, dry pallets should be used in the food industry. Wooden pallets should not be stored un-protected outdoors in order to avoid biological, physical and chemical contamination, see picture 1-4 /13/.



Picture 1 Microbiological and physical hazards

Picture 2 Physical and chemical hazards



Picture 3 Quality problem

Picture 4 Don't store pallets outdoors. Don't stack pallets directly upon each other - put sticks (skids) between the unit loads

But there are also other factors influencing the quality and hygiene of pallets and packaging. As said before nutrition, humidity, temperature, pH and aerobic (or sometimes anaerobic) conditions affect the growth of microorganisms that can destroy or infect food

Temperature has an influence on the survival of bacteria. A general temperature scheme for prevention or killing microorganisms is shown in figure 8.

	+ 130°C	All microorganisms and their spores are killed	Autoclaving
	+ 120°C		
	+ 110°C	All microorganisms are killed, endospores are not affected	
	+100°C		Boiling
	+ 90°C	Pathogens are killed	
	+ 80°C		
	+ 70°C		
	+ 60°C	Slow multiplication of microorganisms	
Danger zone	+ 50°C		
	+ 40°C	Microorganisms are multiplied rapidly in room and human temperature	20-50 °C dangerous zone for food stuff
	+30°C		
	+20°C		
	+10°C		Cool storage
	+0°C		
	-10°C		Freezing storage
	-20°C		Deep freezing
	-30°C		

Figure 8 shows the influence of temperature on microorganisms.

The quality of the wooden pallets is also important. The quality control must secure good trimming of the boards and planing of deckboards is a possibility even if the friction is not as good as for sawn timber. Nailing must be checked – there shall be no protruding nails.

The moisture content of wood has a great influence on the survival and growth of microbes. Below the fibre saturation point (u~ 27%) there is no free water in the cells, which makes it more difficult for microorganisms to survive. A general rule has been that wood shall have moisture content below 20% to avoid growth of mould and fungi. The same goes for bacteria. The higher moisture content the better survival of the bacteria. Therefore pallet should be stored under controlled conditions.

One way to get a water-repellent effect is to treat the timber with a waz emulsion, which is a fairly simple and inexpensive method, se report 5 /12/.

Regarding meat and seafood products it's said that wooden pallets can only be used for transportation of packed products.

Where required there shall be space for storage of food and packaging and devices for loading and unloading. Pallet inverters should be used, see figure 9.

Some foodstuffs are also very sensitive to deterioration in taste by odours. Therefore steel pallets have lately been discussed for food transportation.

To avoid contamination a possible, cheap and easy solution is to use wooden pallets with a slip-sheet on top. When depalletising one pallet the receiving pallet can also has a slip-sheet on top. The pallets can be kept in separate zones and the slip-sheets can be made of different materials, expendable or reusable.

Figure 9. Pallet Inverter should be used for good hygiene /13/.

Hygienic Design

The basic requirements on hygienic design can be summarised as

- Free flow of products in the process - no standstill zones
- Easy to maintain and clean equipment, possible to kill microorganisms on materials
- The product shall not be contaminated from surrounding environment or crossing production lines
- Easy inspection of equipment and validation towards requirements.

In the production area the process flow shall be as straight as possible with separation of clean hygienic zones, as exemplified in figure 10. The flooring shall be non-slippery, non-porous, easy to clean and sanitise and with drainage holes to prevent water pools. The walls shall be

smooth and resistant to damage. Roofing shall be smooth, not keep moisture and flake off. Light fittings shall be secured.

The interpretation has caused problems for the Fisheries in Norway where wooden buildings to a large extent shall be replaced by concrete buildings.

For the Fisheries on Iceland, it is approved to use untreated gluelam in the roof but in the walls usually 1m of concrete is used and then coated gluelam above that. Acryl coating (waterbased) on the gluelam is often used in the buildings today. And as seen from the Icelandic tests (figure 5 and 6), a satisfactory hygienic environment is achieved using gluelam.

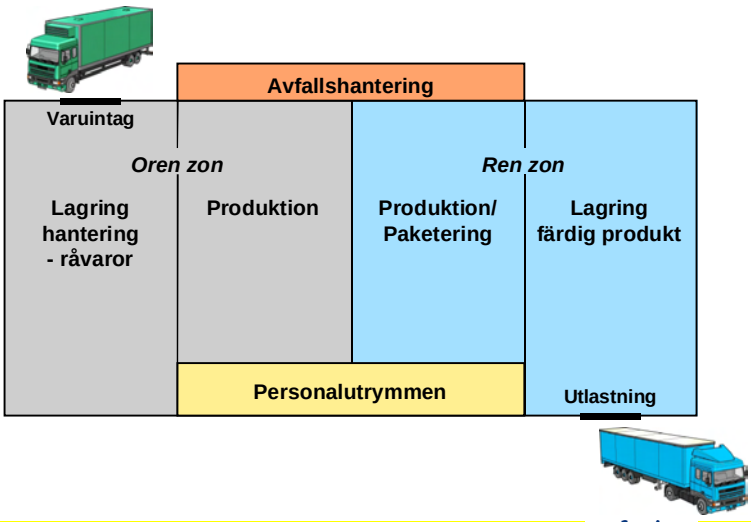


Figure 10. Example of a food plant with one section for unloading /goods reception and part of the production and one hygienic zone for processing, packaging, storage and transportation out from the plant /13/.

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. Hygiene pallets are recommended in hygiene zones. Often the recommendation has been to use plastic pallets with regularly cleaning. The above recent studies have shown that plastic pallets are often not more hygienic than pallets of other materials. Old, scratched, rough surfaces of plastic pallets can host microorganisms and are often difficult to clean properly. Wood is under many circumstances as good as other materials for usage in the food industry.

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.

Heat treatment

Microbes have their optimum temperature. Heat treatment is one way to kill microbes but the temperature needed can vary depending on the type. In the Nordic project both typical bacteria from different food sectors, especially the fisheries, as well as gram positive cocci, gram negative rods and gram positive spore forming bacteria, similar to those found in the meat industry, are studied.

Heat treatment - tested on 19 materials wood, plywood, waxed wood, stainless steel and plastics - at 100 °C for bacteria normally found in cod and 75 °C for bacteria (*Halobacterium salinarium*) from saltfish is sufficient to obtain an acceptable hygienic level, se Report number 7 /14/. Heat treatment can be used for different wood utensils as well as for pallets.

Kiln drying

Kiln drying is a form of heat treatment, which can be sufficient for certain purposes. The following is an example from a producer of protein with severe requirements on the hygienic quality of the pallets. In the Nordic countries the sawn timber is generally kiln dried. The pallet manufacturer dries the timber in an ordinary kiln to a moisture content of 16-18 %. The pallets are manufactured and stored either in a tent or under roof. The day before delivery to the protein producer the pallets are kiln dried once more in a regular drying cycle, transported directly out to a lorry and further to a conditioned storage room at the protein plant. Samples - for total count and number of colonies of mould and yeast - are taken from each batch of pallets for quality control. For this industry the procedure with two cycles in the kiln work satisfactory /15/.

Another possibility is High Temperature (HT) drying with temperatures up to 110-115 °C /16/. So far these HT kilns are not widely used yet in the Nordic countries. But experiments with HT drying of spruce have shown good results regarding the wood properties and an end step with high temperature is one way to pasteurise the wood.

Washing

Ordinary water rinsing can sometimes be sufficient to clean the pallets

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. Figure 11 shows that cleaning with high pressure cold water is very efficient. Microorganisms were not detected on the pallets after cleaning except on plastic pallets made of polyethylene (PE) but the number was very low. According to guidelines used at IFL for surface in direct contact with food this is acceptable. The limit for “acceptable” is 5CFU/cm^2 or below. The HD PE pallets tested were new pallets directly from the plastic pallet manufacturer. The tests on the PE pallets on the other hand were made on pallets already in use in the food industry.

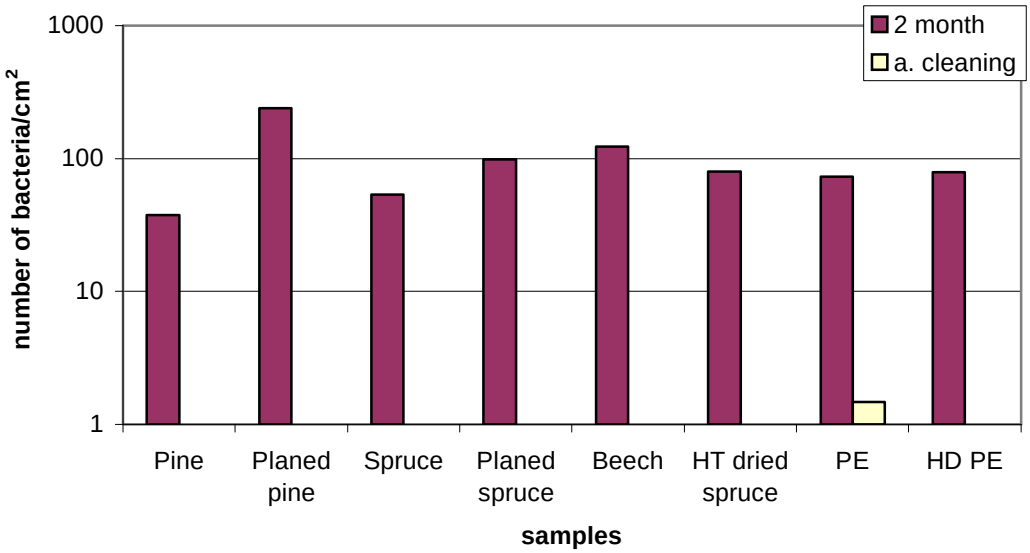


Figure 11. Effect of cleaning wood and plastic pallets using high pressure (180 bar) cold water treatment.

Steam-heating

Brushing in combination with hot steam or hot water sprinkling with dispersion of water in micro droplets (the same system as for fire protection where you want to avoid damage from too much water sprinkling) is a method that also can be used on pallets and packaging.

Super steam pasteurisation -Electro Thermic Bacteriolysis (ETB) process

The Electro Thermic Bacteriolysis (ETB) process was invented for the animal killing industry. Up to 99,9% reduction of all pathogenic bacteria is achieved in short time /16/. This process, with surface disinfection, is said to be a possible sanitation method for wood in combination with other materials.

Radiation

Radiation, i e gamma rays, is a very efficient antibacterial treatment. Radiation has a good potential for the future.

Microwave technology

One of the most promising techniques for pasteurising wooden pallets and packaging is to use microwaves.

The microwave technology is widely used in the many applications today. The microwaves affect the water molecules in the materials. The water is heated and by controlling the process, the technology can be used for heating, drying, hardening and sterilising materials and fluids. Research has been going on in order to dry wood with microwaves. The results are quite promising with short drying time for green timber down to a moisture content of 8 %. Microwave treatment is also used in practice to eradicate the dry rot fungus in buildings. The

microwave technique has for example been developed for sanitising wooden pallets and corrugated boxes for eggs.

The technique was developed for economical and environmental reasons. Egg trays used for transporting eggs from the production site to the packaging department are used 2-8 times before being discarded. Experiments have shown that there is a risk of contamination in recycled fibres, both from animal and human pathogens. In order to maintain the logistics and reuse the egg trays, the egg trays needed to be pasteurised. The egg trays were transported on reusable wooden pallets - EUR-pallets. The pallets are also a risk for contamination. Wet pallets can promote the growth of mould and bacteria. During transportation there is a risk of transferring microbes from one site to another.

Therefore a process was developed to pasteurise egg trays and prevent poultry pathogens to be transferred from one production site to another. A microwave hot air oven were used that could achieve a temperature of 90 °C on the surface of the material. The oven was equipped with 29,6 kW microwave power and 12 kW hot air power. The frequency used was 2,45GHZ. The killing effect on 10^6 CFU of Serratia marescens, an indicator bacteria simulating Salmonella, were validated both on egg trays and EUR-pallets. The tests were performed with moisture content between 5 and 15% on the egg trays and maximum moisture content of 25 % for the EUR-pallets /17/.

There is already a commercially available microwave oven - 2900x2200x2800 mm - that can hold one EUR-pallet with 3000 egg boxes or 12 EUR-pallets in a stack. The power is 35kW The sanitising process will take around 30 minutes /18/.

But bigger ovens can be built or ovens where pallets are treated piece by piece /19/. The microwave oven is intended for food companies so they can keep the pallets in a closed loop. If necessary the pallets can also be washed using high-pressure water sprinkling and then pasteurised in the oven.

In this Nordic project, the effect of microwaves on wood samples of pine and beech infested with Bacillus subtilis (a highly resistant bacteria that forms spores) and Enterococcus faecalis were investigated. Also samples of mould infested board material were tested /20/.

The tests - preliminary studies - were carried out in an old pilot plant oven and the conditions were not optimal. The results showed that the number of organisms - fungi, yeast or bacteria - were reduced radically but not totally. However, there is a good reason to continue to make series of tests in the more advanced oven to find out the right process for different bacteria.

The food industry should use new pallets and keep them in a food loop. Microwave technology can be used for pasteurisation, eventually in combination with high pressure water sprinkling or rinsing if cleaning is necessary. The oven can be equipped with two opposite doors so the pallets are loaded into the oven from one side and unloaded from the other side, which could be into a clean zone.

Pictures below are showing EUR-pallets, Egg Trays and the microwave oven used in the egg industry. Pictures are received from DICAM /19/.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Conclusions

Recent studies in the Nordic countries as well as in Germany and Switzerland have shown that wood in packaging and other applications is as good as any other material for the use in the food industry. But the users need to know better how to handle and store pallets and packaging.

In order to keep a good hygiene there are some general rules for handling and storage of pallets and packaging.

Clean, dry pallets should be used for the food industry. Wooden pallets should not be stored unprotected outdoors in order to avoid biological, physical and chemical contamination.

A general rule is that wood shall have moisture content below 20% to avoid growth of mould and fungi. The same is valid for bacteria. The higher moisture content the better survival of the microorganisms. The quality control must also secure good trimming of the boards, if required the boards can be planed. There shall be no protruding nails.

Keep pallets for hygienic zones well separated.

Where required there shall be room (space) for storage of food and packaging and devices for loading and unloading. Use pallet inverters. Wooden pallets can also be used with a slip-sheet on top for better hygiene. When depalletising one pallet the receiving pallet can also have a slip-sheet on top. The pallets can be kept in separate zones and the slip-sheets can be made of different materials, be expendable or reusable.

If the pallet is dirty, one efficient method to clean the pallet is to use high pressure water sprinkling.

The pallets can be pasteurised by using

- Heat treatment by adding an additional drying cycle in a kiln
- High temperature treatment
- Microwave technology which seem to be a very promising method. For the egg industry this method has been used successfully in Denmark. Preliminary test results using an old oven for samples infected with other types of microorganisms showed that the number of organisms - fungi, yeast or bacteria - was 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.

Microwave technology can be used in combination with high pressure water sprinkling or rinsing if cleaning is necessary. The oven can be equipped with two opposite doors so the pallets are loaded into the oven from one side and unloaded from the other side, which could be into a clean zone.

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

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