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A future with stainless steel shelves in the cheese warehouse

The whole process line for cheese production is made of stainless steel except for the cheese warehouse. According to a long tradition, cheese is ripened on wooden shelves. The relatively bad cleanability is an important disadvantage of wooden shelves. Mould break outs of penicillium discolour in cheese warehouses happen now and then and it is very expensive to control them. Therefore Stafier Holland recently developed a new second generation design of stainless steel cheese shelves and the feasibility of these shelves was tested in cooperation with NIZO food research and a cheese manufacturer.

Stainless steel shelves

Figure 1 shows the stainless steel shelves tested. For the ripening and storage of cheese the industry is continuously looking for shelves that are superior on the following aspects:

- moisture regulation within the cheese
- avoidance of mould formation
- cleanability and hygiene
- effect on cheese flavour/taste
- durability (i. e. robustness of the shelves, lifetime)

In comparison with wooden shelves, stainless steel may have some advantages such as a better cleanability and sustainability leading to lower operational costs in a cheese factory. Tests were needed to prove these advantages.

* www.NIZO.com; www.stafier.com

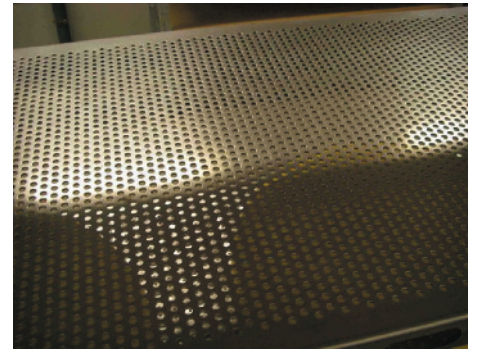
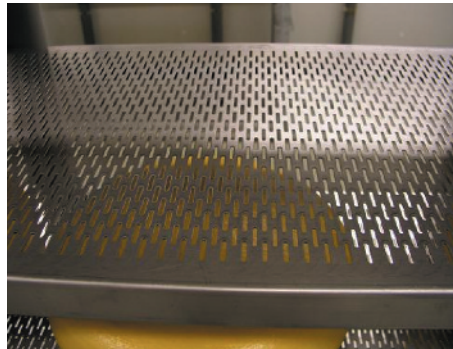


Figure 1: Stainless steel shelves with slit (left, no. 1) and circular (right, no. 2) openings

Pilot trial

Gouda cheese (ten kg) was ripened immediately after brining on stainless steel and wooden shelves for two weeks during a pilot test. The results showed that the average weight loss during ripening was larger for cheese ripened on stainless steel shelves. The larger weight loss is probably due to the many openings in the stainless steel shelves through which the moisture is easily evaporated. The larger weight loss might be compensated for by increasing the moisture content of the cheese during production or increasing the relative humidity in the warehouse during ripening. Only a small spread in weight was seen for the cheeses ripened on a stainless steel shelf with slit openings (figure 1, left). A small spread is favourable as the total moisture content of the cheese can be increased as long as a maximum moisture content in the cheese is constrained. Only minor imprints of the shelf on the cheese surfaces were visible after two weeks. A young

cheese (age four to six weeks) cannot be distinguished from cheese ripened on wooden shelves. As the results of the pilot test were promising a trial on industrial scale was conducted.

Industrial trial

Amsterdam (five kg; high moisture cheese) and Gouda cheese (five kg) were ripened immediately after brining on two different stainless steel (figure 1) and wooden shelves for two weeks in a warehouse of a cheese manufacturer. The wooden and stainless steel shelves were distributed over a cheese box/cabin in such a way that the average weight loss of all the cheeses would be comparable. The results of the Amsterdam cheese (table 1) showed that the average weight loss varies a little, but the spread in weight loss of cheeses ripened on wooden shelves and stainless steel no. 1 were the same.

Table 1: Average weight loss and spread of Amsterdam cheeses during the first two weeks of ripening on wooden and stainless steel shelves

	average weight loss during ripening/day (%)	spread (%)*
wood	0.43	12.2
stainless steel no. 1 (slit openings)	0.41	13.3
stainless steel no. 2 (circular openings)	0.39	20.1

* (standard deviation/average weight loss)*100

Table 2: Average weight loss and spread of Gouda cheeses during the first two weeks of ripening on wooden and stainless steel shelves

	average weight loss during ripening/day (%)	spread (%)*
wood	0.38	14.3
stainless steel no. 1 (slit openings)	0.41	14.2
stainless steel no. 2 (circular openings)	0.38	17.2

* (standard deviation/average weight loss)*100

Table 3: Cleanability of stainless steel and wooden shelves

shelf	before cleaning		after cleaning	
	total count*	yeasts and moulds*	total count*	yeasts and moulds*
wood	7.6.10 ⁶	2.0.10 ⁶	1.5.10 ⁵	2.3.10 ³
stainless steel no. 1 (slit openings)	5.2.10 ⁵	2.6.10 ⁴	<10	<10
stainless steel no. 2 (circular openings)	2.4.10 ³	5.6.10 ³	37	<10

* c.f.u. / 20 cm²

Table 4: Mirco-organisms present on shelves and Gouda cheese rinds after two weeks ripening

	shelves		Cheese rind	
	total count*	yeasts and moulds*	total count**	yeasts and moulds**
wood	3.1.10 ⁷	5.6.10 ⁴	8.2.10 ⁸	1.8.10 ⁵
stainless steel no. 1 (slit openings)	2.3.10 ⁶	3.9.10 ³	4.1.10 ⁹	1.4.10 ⁶
stainless steel no. 2 (circular openings)	1.3.10 ⁷	2.1.10 ⁴	7.0.10 ⁸	1.5.10 ⁶

* c.f.u. / 20 cm² ** c.f.u./g cheese

The same results were obtained with Gouda cheese (table 2).

It seemed that the stickiness of Amsterdam cheese ripened on stainless steel was less than that on wooden shelves.

Hygiene

The cleanability of the stainless steel and the wooden shelves was tested by determining the total count and the number of yeast/moulds before and after cleaning. The results (table 3) show the much better cleaning efficiency of stainless steel.

Whereas the total count reduction was two to five log-values for stainless steel the reduction was only one log-value for wooden shelves. The smooth stainless steel surface compared to the rough surface of wood will lead to this advance. An undesired microbial contamination on a stainless steel shelf can be easily removed

Figure 2: The results of the sensory evaluation of the cheese

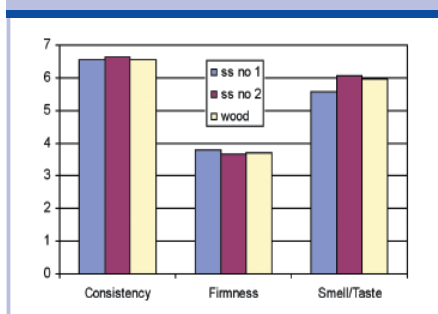


Table 5: Estimated annual savings after replacing wooden shelves by stainless steel

advantage	annual savings for a cheese manufacturer (annual production: 50 million kg cheese) in euros
less (cleaning) water desorption in the cheese warehouse	10,000.–
less mould outbreaks	50,000.–
less cleaning agents	50,000.–
total	110,000.–

whereas the same contamination on wooden shelves might contaminate new cheese. Mould outbreak of *Penicillium* discolor still frequently happens in cheese warehouses. It is costly and time consuming to remove them.

Cheese quality

Table 4 presents the results of micro-organisms present on the shelves and on the cheese rinds after two weeks ripening.

The level of total count and yeast and moulds was the same on wooden and stainless steel shelves after two weeks. Also comparable results were obtained from cheese rinds in contact with wooden and stainless steel shelves. This is a good result as micro-organisms present on cheese contribute to the taste and smell development of natural ripened cheese.

The cheeses were finally judged by a sensory panel after a ripening period of six weeks on wooden and stainless steel shelves. The cheeses were evaluated on taste/smell

consistency and firmness (see figure 2). No significant differences were observed between the cheeses. Also no rind defects were noticed. Thus stainless steel does not influence the quality of the cheese.

Up to now it was thought that stainless steel could only be used for cheeses from the age of at least two weeks. The current results show that stainless steel shelves are suitable for the ripening of cheese immediately after brining.

Potential savings

The wooden shelves absorb very little moisture from the cheese. However, due to wet cleaning a lot of water is introduced via the wood into the cheese warehouse that has to be removed again. This requires additional energy for climate control. With stainless steel this is not the case. As a result of the increased cleanability of the stainless steel the risk of mould outbreak is reduced. This will definitely lead to cost

reductions. In addition, with stainless steel shelves less cleaning agent is needed.

Table 5 gives an estimation of the potential savings in euro based on industrial data.

Conclusions

From the research it appeared that stainless steel shelves with slit openings give the best results. The spread in weight loss and the overall cheese quality are the same for cheese ripened on wooden and stainless steel shelves. Stainless steel shelves can be used immediately after brining. Stainless steel shelves have the following additional advantages above wooden shelves:

The cleanability of stainless steel is much better compared to wooden shelves. This will improve the hygiene in the ware-house and lower the risk of mould breakout. Cheese does not stick to the shelves. Moreover, it is estimated that an average cheese manufacturer will reduce his cheese ripening costs by more 100,000 euro a year.