

A: Title page

Coolnova®

Fresh from Frozen. Seafood Just-In-Time Year Around!

By

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B. Problem Statement

Freshness is the highest valued food quality in all consumer markets across all cultures. The limited shelf life of fresh high-quality food is a main important constraint in food marketing. Seafood can only be preserved the good-quality freshness on ice at maximum about 10–12 days or even shorter for raw fish products like sushi. When the supermarkets may require a 7-days sales period, there is only 3-4 days left for transportation from the point of harvest to the supermarkets. The risk of quality degradation and losses is high in fresh fish marketing if some links in the production chain cause delays like bad weather or transport problems. The limited fresh shelf-life requires expensive airfreight beyond distance that cannot be reached by land or sea transport.

The marketing process of fresh wild caught fish distributed to the big consumption cities around the world becomes even more complicated caused by the seasonal character of the fish harvest taking place in remote areas like Bering Sea in Alaska or the Barents Sea in Norway. Only 13 per cent of the Norwegian wild caught cod fish were for example in 2011 exported fresh compared to 86 per cent of the Norwegian farmed salmon caused by lack of marketing control over the production chains. Most wild seafood is therefore preserved and marketed by freezing or salting to a significant lower value compared to the similar fresh fish. Variation of the raw material quality and the difficulties for the consumers to sense the quality clues before purchasing are other constraints reducing the quality trust of frozen fish.

C. Objectives

This paper will report from a research project carried out since 2007/2008 which has identified management opportunities by application of novel production chain technologies required for supplying the consumers fresh quality seafood everywhere every time. The solution relies on 1) Fresh freezing of seafood products when the production quality and costs are most favourable 2) Frozen buffer storage 3) Thawing and 4) Distributed fresh chilled just-in-time for sales and consumption.

D. Procedures

This research is carried out in cooperation between researchers at the University of Tromsø in Norway, food technology institutes in Spain (Azti) and Germany (ttz) together with

European seafood processing and distribution companies, partly financial by a Norwegian governmental grant.

Several available industrial methods for freezing and thawing were evaluated. The initial study concluded that raw material freshness at the point of freezing and the thawing process were most important for improving fresh quality to the consumers as long as modern well known freezing technologies are applied. The project identified and tested a German thawing method judged to offer the best thawing results for fresh frozen seafood. Only the bakeries have applied this technology earlier in the food industry. A European patent was filed in 2012 for the application in seafood, meat and vegetables/fruit branded as Coolnova® after the name of the research project.

The frozen food is in this system thawed at a temperature $<+30^{\circ}\text{C}$ in a chamber saturated with a water-mist atmosphere consisting of micro and nano sized droplets produced directly from purified water without boiling and water waste. The low thawing temperature is important to hinder any unwanted biological processes to take place. The energy consumption is estimated to 2-5% compared to other systems where vapour is produced by boiling and cooling and the droplets size to less than 10% compared to droplets high pressure by nozzles systems where only 50-75% of the water is recovered to vapour.

E. Results

This Coolnova® thawing atmosphere keeps up a moist equilibrium between the product and the environment. The micro-nano sized droplets are so small that they penetrate all loopholes in the porous meat and the thawing time is so fast (fillets about 50 min) that **no dehydration** and drip-loss take place. It means that the process protects against the denaturation damages of the water holding soluble proteins otherwise caused by air contact (oxidation of cell membranes) and osmosis in slow thawing processes. Denaturation of the water soluble protein is believed to be responsible for changes in the water-holding on storage (Offer and Knight, 1988, Munasinghe et.al., 2005). When the products are not dehydrated and the biological processes not even have had the chance to start, the original fresh *quality, taste, smell and appearance and the original weight* are also prevented after thawing. Quality out is like quality in.

We have tested several seafood products. The results are consistent. There is no drip loss of any of the fresh frozen products we have thawed in the Coolnova® atmosphere. The thawed seafood looks shiny exactly as a newly cut fresh fish.

We have also thawed fresh frozen sushi. The results are very promising. Traditional frozen and thawed sushi rice tastes hard and sticky caused by dehydration. When thawed in the Coolnova® atmosphere, the sushi rice keeps the softness of the rice and the fish looks shiny similar to newly made sushi. A sushi restaurant chain is currently evaluating this industrial opportunity.

Discussion

Coolnova® is a method for recovering fresh quality properties from fresh frozen food which can be offered consumers without other preservation agents than freezing. Thawing chamber sizes may be applied according to the required capacities in restaurants, supermarkets or distribution platforms close to and just-in-time for the final sales through fresh seafood service counters or for daily fresh looking pre-packed without drip-loss in the packages. Pre-frozen food has actually a longer shelf-life after thawing compared to ordinary fresh unfrozen products, because of the bacteria killed effect from freezing. The thawing technology may in the future be applied even to ovens in private kitchens.

Coolnova® may eliminate the shelf life "X" factor in wild seafood distribution which may be converted into an aquaculture market J-I-T model. Processing of fresh-frozen products of all kind of fish species and products may take place of at source when the fresh quality is best and harvesting costs are lowest. Later the products may be transported frozen close to the final market place and stored. Thawing and final distribution to fresh service counters or as pre-packed products takes place on demand just-in-time before sales.

The main industrial advantage of the Coolnova® technology is the opportunity to offer fresh quality appearance seafood anytime, everywhere, which normally generates higher market prices and volumes. Fresh fish distributors may also get access to new fish species sensitive to traditional freezing and thawing methods (e.g. hake). The cost savings are also significant: While the thawing cost is marginal, may drip-loss and losses caused by direct quality degradation of fresh seafood be 5-10% of weight throughout the distribution system and 3-5% (drip-loss) by traditional thawing of frozen seafood.

More important, the transportation costs savings by moving food from air-freight fresh iced forms to frozen forms in sea/land containers might represent up to 30-40% of the product costs at the market place. For example flying fresh salmon from Norway to Japan and China may cost 2.5-3.0 US\$/ kilo compared with 40-50 cent/kg in frozen by sea containers. Most Norwegian salmon are today exported whole head-on because the fresh fillets lose the fresh appearance when the surface is dehydrating under transport. By applications of the Coolnova® method, the fresh and shiny surfaces of the fillets are maintained after thawing. It means that Norwegian salmon export profile may be changed from whole fish to fillets without using methods like CO treatment already applied in the frozen tuna industry to keep the collar (Kristiansson et.al. 2006). This change will reduce the transportation costs additional 40% which is the weight of the fish head and backbone.

F. Conclusion

Marketing of fresh quality thawed foods Coolnova® atmosphere may give a good opportunity to increase the value both in term of higher consumer values, higher sales volumes and lower distribution costs, especially for seafood. The main advantages are that the fresh shiny appearance with clear collar and juicy taste are maintained without use of any chemical additives. The thawed sushi rice is kept soft, fluffy: like newly made without the tendency of strange, dry, hard, crumbly texture well known in sushi previous frozen or even after overnight in a refrigerator. The Coolnova® method opens also for cost reductions of 3-10% by less drip and quality losses and 80-90% reduced transportation costs by moving the goods from air to sea and land.

The Coolnova® technology is now under testing by fish distributors in wholesales, supermarkets and of restaurants. The drip-loss and quality losses are similar in the meat industries. Vegetables and fruit are also interesting applications to be tested together with good partners. The commercialisation process is followed up by an active R&D effort. Partners are welcomed for testing and evaluation of the application in various value chain, product and marketing application. The food distribution revolution is just started.

Selected references

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