

Consumer and Time-Temperature Indicator: Implications for Further Development



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Background and aim of the study

- Ensuring the food quality and freshness is extremely important for all packaged meat, fish and poultry chain members
 - Manufacturers
 - Suppliers
 - Retailers
 - Consumers

- Different technologies have been introduced to monitor food freshness and the integrity of cold chain
 - Electronic nose (Rajamäki et al., 2006)
 - Intelligent labels (CTIs, CTTIs and TTIs) (e.g. Järvi-Kääriäinen & Leppänen-Turkula, 2002)

- Several benefits are associated with intelligent labels
 - Cost-effective and user friendly tools (Vaikousi et al., 2008)
 - Accurate prediction of shelf-life and/or replacement of expiration date label (Bobelyn et al., 2006)

So, intelligent labels should add value to the entire chain...

Background and aim of the study

...however, no broader market penetration exists today despite the decades of R&D (Taoukis, 2011)

- The reasons for market neglect remain somewhat unclear
- Thus, the aim of the study is *to understand the factors decreasing and increasing Finnish consumers' interest in intelligent labels in order to generate implications for further technology development*

Methodology

- TTIs in focus as the technology is capable of monitoring the entire time-temperature history since the activation of label
- Packaged fresh and frozen meat, fish and poultry products
- Qualitative method (focus group discussions) was applied
 - Enables rich data to understand the studied phenomenon broadly (e.g. Denzin & Lincoln, 1994) – especially useful in this case due to the limited knowledge on Finnish consumers' perceptions on TTIs
 - Finnish consumers do not hold vast knowledge on TTIs – chosen methodology allows researcher to be involved and describe the TTIs to participants leading to richer and broader data (e.g. Hirsjärvi & Hurme, 1991)

Methodology

- Focus groups were divided into three parts with emphasis on generating as much knowledge as possible:
 1. General discussion on fish, meat and poultry consumption, products and packages – to warm up the participants and guide them to the study topic
 2. Presentation of TTI concept and development of an "ideal TTI" – present the concept and enable the participants to evaluate it and also to characterise an ideal TTI application
 3. Presentation of two actual TTI applications – to capture consumers' perceptions of two commercially available TTIs

Generation of understanding on factors affecting consumers' interest in TTIs and implications for further technology development

Methodology

■ Description of TTI concept

Time-Temperature Indicator (TTI)

What does it mean?

Rise in temperature during storage and delivery of a food product can boost microbial growth which leads to product spoilage. The product might no longer be safe for food consumption. The basic idea of TTIs is to monitor that food products have not exposed to unwanted temperatures too long.

Time-temperature indicators (TTIs) are labels which monitor the different temperature of products such as fish, meat and poultry from production until the consumer's fridges. TTIs can be attached to different food packages and they are relatively small in size.

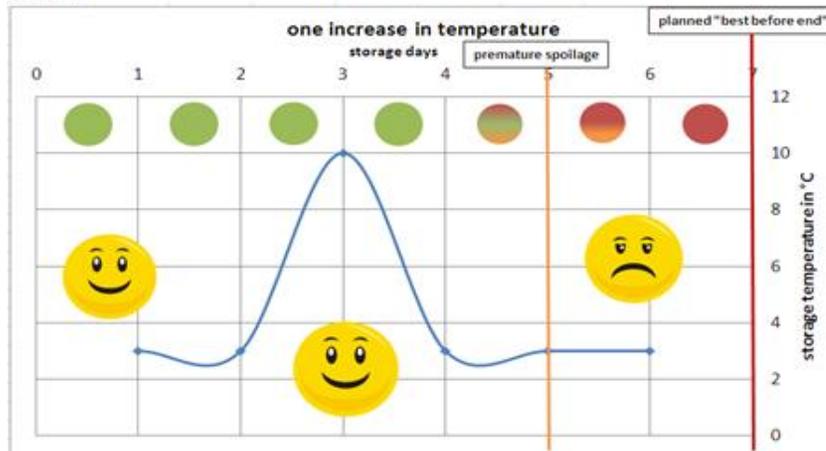
How does it work?

TTI has a symbol which changes colour. In case of exposure to unwanted temperature, the colour will change (e.g. from green to red) which indicates that product might be in risk of deterioration and it should be consumed with caution. Due to the technology behind TTIs, the colour change is irreversible.

The TTI is sensitive to changes of temperature. The time and temperature increase have influence on the colour change and therefore on the remaining shelf life. Following scenarios try to explain what is behind different colours of the labels.

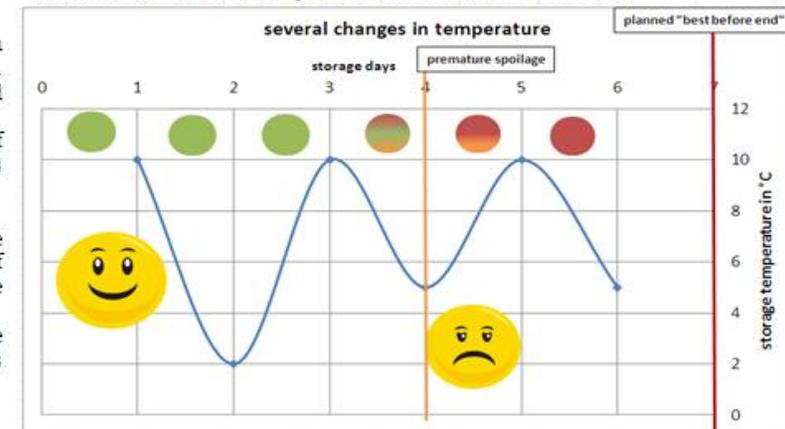
Scenario 1:

Short raise in temperature: TTI records the exposure. The colour turns to red indicating premature spoilage before the "best before" date. The product should be consumed with caution.



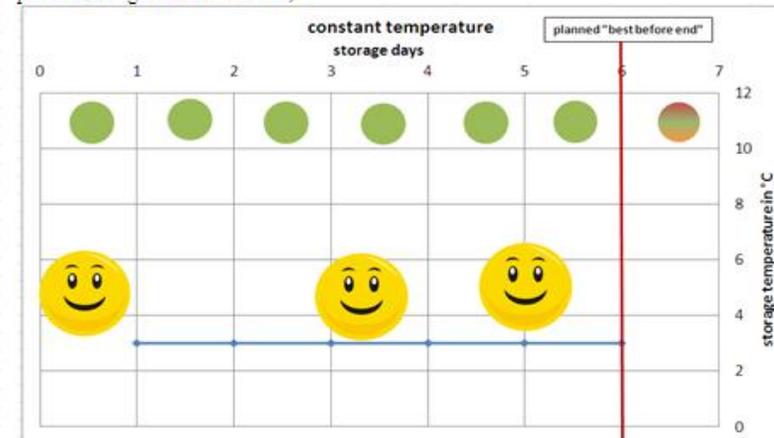
Scenario 2:

Long or several raises in temperature: Product changes will be indicated, even before the "best before" date. The product should be consumed with caution.



Scenario 3:

No raises in temperature: TTI remains green till the "best before" date and even after. However, product changes will be indicated eventually after "best before" date (e.g. if the product is forgotten in the freezer).



Methodology

- Four focus groups with altogether 29 participants were conducted in Helsinki area during May 2012

- Participants were recruited based on the following criteria
 1. Group 1-2 (adult household without children including single households)
 2. Group 3-4 (adult household with children including single parent households)
 3. Not recently participated in focus groups
 4. Aged between 20-50 years
 5. Regular users of fresh/frozen packaged fish and/or meat and/or poultry products
 6. Purchasing food mainly in super/hypermarkets
 7. In maximum two technically oriented participants per group

Methodology

- Interviews were conducted at the facilities designed for focus groups
- Duration of the focus groups were approximately 2 hours
- All focus groups were both tape and video recorded

- Analysis of the data – two steps:
 1. Emphasis on iteration to generate provisional understanding on data, challenge it and further develop it through an ongoing iterative process (cf. Thompson, 1997; Thompson & Troester, 2002)
 2. Generation of more general and abstract categories based on the individual observations on data (cf. Glaser & Strauss, 1967; Strauss & Corbin, 1990)

Findings

1. Benefits of TTI concept – three categories emerged

Safety	Assistance	Excitement and easy to use
<ul style="list-style-type: none"> Enables to see objectively if the product has been exposed to unwanted temperatures 	<ul style="list-style-type: none"> Would function as additional selection criterion 	<ul style="list-style-type: none"> Innovative, reassuring and impressing technology
<ul style="list-style-type: none"> Increases reliability toward food products (also those sensitive to temperature changes) 	<ul style="list-style-type: none"> Considered relevant for consumers in general – feels as good idea 	<ul style="list-style-type: none"> TTI concept and the benefits well understood
<ul style="list-style-type: none"> Forces stakeholders to pay attention to cold chain thus possibly intensifying it 	<ul style="list-style-type: none"> Relevant in controlling consumption and wasting of food 	<ul style="list-style-type: none"> Easy to interpret
<ul style="list-style-type: none"> Triggers awareness of factors impacting product quality 	<ul style="list-style-type: none"> Relevant for frozen products, fish in vacuum, MAP products and products with marinade 	
<ul style="list-style-type: none"> Increases sense of security to food preparation in important situations 	<ul style="list-style-type: none"> Useful for monitoring cold chain while transporting food or when storing at home 	

"I can not come up with any real flaws. You know the product hasn't gotten old on the way back home and when you buy something you know that the cold chain has not been interrupted...M/G3

"Shielding gas changes its smell and everything. You can not say how fresh it is. You just have to look at the expiration date. This would help a bit." M/G2

"My grocery shopping is very quick and this label could probably just make it even quicker. I would just check that this is green, so it is ok – I'll take this." F/G3

Findings

1. Prejudices towards TTI concept – three categories emerged

Mistrust/suspicion/doubt	Confusion/difficulty/ stress	Monetary concerns
<ul style="list-style-type: none"> • TTIs might not be reliable 	<ul style="list-style-type: none"> • Constant monitoring of purchased food products 	<ul style="list-style-type: none"> • Increased price of food products
<ul style="list-style-type: none"> • Personal responsibility is outsourced leading to disregard behaviour 	<ul style="list-style-type: none"> • Confusion in adapting TTI message in own behaviour 	
<ul style="list-style-type: none"> • If the label fails to communicate whether the product is actually spoiled or not, it is almost as good as nothing 	<ul style="list-style-type: none"> • Confusion between best before - date and TTI message 	
<ul style="list-style-type: none"> • Increased food waste 		

"Would you have courage to use it after the expiration date? This label doesn't measure anything else than the cold chain." F/G3

"How reliable this really is and is there a possibility that food is thrown away too soon." M/G2

"I would not pay more than 5-10 cents extra for 400g of minced meat." F/G1

Findings

2. Ideal TTI – 10 characteristics

Technological features

1. Ideal TTI should unambiguously show if the product has been exposed to unwanted temperature
2. The moment when the product has been exposed to warmth should be visible, because the number of bacteria will continue to increase even if the product is cooled down again. Some participants figured that the longer the time after the moment of exposure the more bacteria in the product
3. Ideal TTI should show how many days the product has been stored. Also the date when the TTI has been attached to the package should be visible.
4. Ideal TTI should not be inclined to any manipulations. It should not be reversible or easy to remove or change unnoticeably

Design

1. Ideal TTI should be very clear and big enough but not too big to spoil the appearance of the packaging
2. Ideal TTI should be very clear to interpret. It should not make shopping more complicated but rather quick and easy
3. Ideal TTI has to be uniform in all types of packages. What is more, all the different manufacturers should use the same label

Other

1. Ideal TTI cannot be introduced by private companies but by some official authority
2. Supervision of the ideal TTI should be in the hands of authorities. The reliability should also be investigated by some authority
3. It should be clearly stated that ideal TTI does not guarantee that the food is fresh and eatable

Findings

3. Actual TTI applications – benefits

Benefits	TTI1	TTI2
Easiness to use	<ul style="list-style-type: none"> • Easy to understand, use and interpret • Written instructions and universal red-green colours 	
Credibility, quality and security	<ul style="list-style-type: none"> • Irreversible colour change increases credibility • Additional guarantee of quality • Useful for own cold chain management to ensure food quality 	<ul style="list-style-type: none"> • Separate activation of each label increases reliability • Does not contain liquids
Other benefits	<ul style="list-style-type: none"> • Relevant to fish and frozen products • Provides assistance to choose “best” products • Adds some value to any product • Product with TTI1 would be chosen instead a product with approx. same price with no label 	<ul style="list-style-type: none"> • Interesting activating mechanism

“These colours are automatic. They are in our subconscious somehow, green us OK and red is not OK.” M/G1/TTI1

“It attracts me that it is activated separately. You do not know of TTI1 how long it has been stored.” M/G2/TTI2

“It is positive that the change is irreversible. It can’t change from red back to green.” F/G3/TTI1

“I think this label would provide me information I cannot acquire otherwise. It would bring me more security.” F/G3/TTI1

Findings

3. Actual TTI applications – prejudices

Prejudices	TTI1	TTI2
Mistrust, suspicion and doubt	<ul style="list-style-type: none"> • Removable and unreliable • Unsafe label (toxicity, possible leaks) • Technology limited only on monitoring temperature (TTI cannot tell if the product is spoiled in some other way) • Confusion between expiration date and TTI message • Increased waste (in the beginning) 	<ul style="list-style-type: none"> • Removable and unreliable
Confusion, difficulty and stress	<ul style="list-style-type: none"> • Difficult to interpret the colours and shapes • Unappealing appearance 	<ul style="list-style-type: none"> • Difficult to interpret the colours and shapes
Monetary concerns	<ul style="list-style-type: none"> • Moderate willingness to pay extra 	<ul style="list-style-type: none"> • Unwillingness to pay extra

"I would say that this is of no use because it tells nothing about the product itself. I just would not trust this."
F/G2/TTI1

"This is even more open to various interpretations than TTI1" F/G1/TTI2

"It took me a while to understand how this works." M/G2/TTI2

"This is not useful to me, because I cannot understand this properly." F/G3/TTI2

"This resembles a pregnancy test."
F/G4/TTI2

Conclusions

- Participants associated several benefits with **TTI concept** and in general the **concept** was perceived positive and useful for packaged meat, fish and poultry products

- **Actual TTIs** did not meet the consumers' expectations though TTI1 performed relatively well – lot of things to improve

- Main problems to tackle in further TTI development:
 1. Confusion among consumers how to interpret TTI → No intermediate colours and/or weak colour contrast
 2. Confusion among consumers how to adapt TTI message into their own behaviour → No cryptic "thermometers" in TTIs but clear graphical – or even better – written instructions
 3. Worries among consumers that retailer/manufacturer manipulates TTI → No label but integrated TTI as part of packaging
 4. Confusion among consumers which freshness indication to trust → TTI needs to be in line with other freshness indicators

Thank you for your attention!

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VTT creates business from technology