

# **Consumer attitudes towards oxygen absorbers in food packages**

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## ABSTRACT

A consumer survey preceded by a pilot study consisting of personal interviews was conducted in order to determine consumer attitudes towards oxygen absorbers used in food packages. The consumer survey questionnaires were given out with food samples (pizza with ham filling and sliced rye bread) packed both with and without an oxygen absorber in three Helsinki area supermarkets. Three hundred and fifty-two satisfactory responses were returned, resulting in a response rate of 89%. Half of the consumers received an information leaflet about oxygen absorbers.

Overall, 72% of consumers accepted the use of oxygen absorbers and 23 % could not decide. The acceptance was higher among those who received the information leaflet - 76% vs. 67% in the 'no information' group ( $p = 0.03$ ). However, the information given appeared to have no effect on negative responses - in both groups, ca. 5% of consumers did not accept oxygen absorbers.

Consumers who held a negative attitude towards food packaging and long shelf-lives also expressed more negative attitudes towards oxygen absorbers ( $p < 0.001$ ). Correspondingly, consumers accepting the use of additives favoured the absorbers ( $p < 0.01$ ). Gender, age, education or other demographic factors were not related to the attitudes towards oxygen absorbers. The use of absorbers was accepted well in the sample foods (pizza 62% and rye bread 57%) used in this study, whereas only 29 % would accept them in fresh meat. Respondents who

used pizza and sliced rye bread were frequently more in favour of absorbers. Forty per cent of consumers were willing to pay at least 10 pennies (FIM 0.1) more for products with an oxygen absorber.

In voluntary comments the reduction in the amount of additives used in food products was regarded as the absorber's major advantage, whereas their 'harmful substance' and the waste produced were seen as the major disadvantages. The main concerns were that the absorbers would break up inside the package or they would fall into the possession of children or pets.

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## TIIVISTELMÄ

Kuluttajatutkimuksella ja sitä edeltäneellä henkilökohtaisista haastattelusta koostuneella esitutkimuksella haluttiin selvittää kuluttajien suhtautumista elintarvikepakkauksissa käytettäviin hapenpoistajiin. Kyselylomakkeet ja näyte-elintarvikkeet (kinkkupizza ja viipaloitu ruisleipä), jotka oli pakattu sekä ilman hapenpoistajaa että hapenpoistajan kanssa, jaettiin kuluttajille kolmessa pääkaupunkiseudun elintarvikemyymälässä. Hyväksytyjä vastauksia saatiin 352, vastausprosentti oli 89 %. Lisäksi puolet kuluttajista sai hapenpoistajista kertovan lisäinformaatiolehtisen.

Kaikkiaan 72 % kuluttajista hyväksyi hapenpoistajien käytön elintarvikkeissa ja 23 % ei ilmaissut kantaansa. Lisäinformaatiota saaneet kuluttajat hyväksyivät hapenpoistajat paremmin - 76 % vs. 67 % ilman informaatiota jääneiden ryhmässä ( $p = 0,03$ ). Kielteisesti hapenpoistajiin suhtautuneiden määrään lisäinformaatiolla ei ollut kuitenkaan vaikutusta - kummassakin ryhmässä n. 5 % kuluttajista ei hyväksynyt hapenpoistajia.

Kuluttajat, jotka suhtautuivat kielteisesti elintarvikepakkaamiseen ja pitkiin säilyvyysaikoihin, suhtautuivat myös muita vastaajia kielteisemmin hapenpoistajiin ( $p < 0,001$ ). Vastaajista taas lisäaineiden käytön hyväksyneet kuluttajat suhtautuivat muita myönteisemmin myös hapenpoistajiin ( $p < 0,01$ ). Hapenpoistajien käyttö hyväksyttiin parhaiten näyte-elintarvikkeissa (62 % pizzassa ja 57 % ruis-

leivässä), kun taas vain 29 % ilmoitti hyväksyvänsä hapenpoistajien käytön raa'assa lihassa. Einespizzojen ja viipaloidun ruisleivän ”suurkuluttajat” suhtautuivat hapenpoistajiin muita vastaajia myönteisemmin. Neljä kymmenestä vastaajasta oli valmis maksamaan hapenpoistajan kanssa pakatusta elintarvikkeesta vähintään 10 p enemmän kuin tavallisesta pakkauksesta.

Lisäaineiden määrän vähentämisen elintarvikkeissa koettiin olevan suurin hapenpoistajien tarjoama etu, kun taas pussin ”haitallinen sisältö” ja siitä syntyvä jäte koettiin suurimmiksi haitoiksi. Kuluttajien suurin huolenaihe oli se, että hapenpoistajapussi hajoaa pakkauksessa tai joutuu lapsille tai lemmikkieläimille.

## PREFACE

Since 1991, VTT Biotechnology and Food Research has carried out several projects to study the effect of oxygen absorbers on the preservation of different foodstuffs. In the course of these projects, an increasing interest in the consumer response to oxygen absorbers has arisen, given that the topic has not yet been studied. A common belief has been that consumers would not accept a separate or visible sachet in a food package. In general, the whole concept of extending shelf-life only by removing oxygen from a package has been considered too difficult for consumers to understand. In 1995, Biofincon Oy, Fazer Leipomot Oy, Mitsubishi Co., Saarioinen Oy and VTT decided to finance a study on consumer attitudes towards oxygen absorbers. The study was carried out in co-operation with VTT, the University of Helsinki, the Association of Packaging Technology and Research (PTR) and the companies concerned. It has also become affiliated with the EU-FAIR research project entitled 'Measurements of consumer attitudes and their influence on food choice and acceptability' (AIR-CAT).

The authors wish to thank the companies for taking part in financing and providing the sample foodstuffs and the product packages. We would also like to thank Research Scientist Eira Laurila and Professor Saara Hyvönen at the University of Helsinki for their work on the project's supervisory committee. We would also like to express special thanks to Mrs Kirsi Norberg-Haggren and Mrs Heidi Eriksson for their help in dealing out the food samples. The assistance of Mrs Ulla Österlund and Miss Heli Nykänen, and all those who have been members of the sensory panel is also highly appreciated.

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# 1 INTRODUCTION

The preservation of foods and the food quality have always been important to consumers. Furthermore, the consumers in industrially developed countries are increasingly demanding foods that have ‘fresh-like qualities’ and are convenient but nevertheless have a long shelf-life for distribution. These demands have led food companies to further develop traditional preservation methods and also to discover new methods that cause minimal adverse changes in food, yet offer desirable benefits derived from an increasing shelf-life. This new approach has become known as ‘minimal processing of foods’. It includes optimized traditional preservation methods (e.g. canning, freezing, drying and fermentation) and novel preservation methods (e.g. non-thermal processing, mild heat treatments, ‘sous-vide’ cooking, post-harvest technologies and protective microbiological treatment). Minimal processing also consists of a combination of these various methods and techniques including packaging, whereby a synergistic effect is obtained.

Active packaging is known one of the techniques used in conjunction with minimal processing. In the present, commercially significant packaging techniques, the term ‘active’ refers to a method of modifying package atmosphere actively and continuously, in contrast to the traditional gas-flushing technique. The atmosphere can be modified either by separate components absorbing/emitting gas or by packaging materials containing preserving compounds. Oxygen absorbers, ethanol emitters/generators and ethylene absorbers are the most important active food packaging methods.

Given that the above-mentioned preservation techniques have been invisible to consumers, active packaging with small sachets or labels in packages has become the first technique to depart from this norm. Although oxygen absorbers have been used in Japan for the last two decades, and have also been well received by consumers, they are still only an occurrence in the European market. The

manufacturers' main concern seems to be that consumers will consider the components harmful and will not accept them.

Very little research has been done up to the present consumer attitudes towards the separate components used in food packages. One study by the British National Consumer Council (1991) studied consumer attitudes and behaviour with respect to time-temperature indicators (TTIs) in food packages. In general, the respondents expressed a very positive attitude towards the introduction of TTIs. However, the responses varied according to consumer personality type, as the reactions were less positive among the 'non-cautious' types who worried less about food safety in general.

Several studies have examined consumer attitudes to other novel techniques such as food irradiation (e.g. Bruhn 1995; Resurreccion *et al.* 1995) and genetic engineering (e.g. Sparks *et al.* 1994). Consumer concern for food safety in general has also been an issue in the latest studies (e.g. Brewer *et al.* 1994). According to Brewer *et al.* (1994), consumers who are most concerned about food safety express more concern over 'chemical issues' (e.g. hormones, additives, pesticide residues and irradiation) than over 'spoilage issues' (e.g. improper food preparation, microbial contamination and restaurant sanitation). Part of this heightened concern about the current 'hot topics' is seen to result from a low level of knowledge and a lack of understanding (Brewer *et al.* 1994).

When introducing a new technology to the market, the manufacturer has to decide which channels to use for providing the necessary information to consumers. In recent studies it has been suggested that the social context or derivation of messages concerning potential hazards to society (e.g. genetic engineering) are likely to be as important as the information conveyed (Frewer & Shepherd 1994). While information about risk can be communicated through a variety of channels, public attitudes and reactions to the potential hazard may be dependent on the extent to which the source of the message is trusted by members of the public. According to Frewer and Shepherd (1994) current affairs television programmes, quality

newspapers and consumer organizations are the sources most trusted by consumers, whereas the food industry and government are the least trusted information sources. Their results nevertheless indicated that the stated trust in risk information sources and actual reactions to information can not be equated. Further investigation is still needed, as the relationship between information source and subsequent behaviour may be determined by interactions between information source, hazard characteristics and the personal attributes of the receiver (Frewer & Shepherd 1994).

To carry out the present consumer study, it was considered helpful to interview some of those who provide consumer information in order to get a general overview of their thoughts about separate shelf-life extending components in food packages. In contrast to the results of Frewer and Shepherd (1994), there is no evidence in Finland that government food administrators are less trusted by consumers than are retailers or consumer organizations, which together play an important role as providers of consumer information.

## 2 AIMS

The aims of the study were to find out:

- 1) what providers of consumer information (government ministries, retailers, consumer organizations and the media) think about components which increase food shelf-life and safety,
- 2) how positive or negative are consumer attitudes towards oxygen absorbers,
- 3) how information may influence consumer attitudes,
- 4) how demographics, food neophobia, attitudes towards prepacked food, additives, long shelf-life and the price/quality relationship affect the acceptance of oxygen absorbers.

## 3 MATERIALS AND METHODS

### 3.1 INTERVIEWS OF CONSUMER INFORMATION PROVIDERS

A pilot study was carried out in order to examine the opinions of those organizations that provide consumers with information about matters pertaining to food. Twenty-one persons (3 male and 18 female) representing government ministries, retailers, consumer organizations, press and TV/radio reporters, were interviewed. Each interview lasted approximately one hour and took place in the interviewees' office.

The interviews consisted of 17 open questions and dealt with the following topics:

- 1) Personal background
  - work experience and knowledge of food packaging
- 2) Food packaging
  - most important characteristics of food packages
  - identifying vacuum and modified-atmosphere packages
- 3) Other considerations with respect to food packaging
  - shelf-life and safety of foodstuffs
- 4) Separate components in food packages
  - need for separate components
  - anticipated/forecast consumer reactions
  - marketing of components

In the second part of the interview, the respondents were shown pictures of vacuum and modified-atmosphere packaged foodstuffs and were asked whether they could identify the packaging technologies used. The purpose of this question was to get a general idea of the level of the respondent's knowledge about modified-atmosphere packaging.

Before the set of questions about separate components, each respondent was presented a short brochure which described each component's ability to increase food preservation or safety. The components introduced were oxygen absorbers, carbon dioxide emitters/absorbers, ethanol emitters, ethylene absorbers, moisture adsorbers, time-temperature indicators, oxygen- and leakage indicators and tamper-evidence indicators. In addition, participants were shown a number of pictures illustrating the placement of components in the package and demonstrating their effect on food preservation or on safety. This was done in order to give the respondents general information about the components so that they would all have an equal point of departure for answering the questions.

## 3.2 CONSUMER SURVEY

### 3.2.1 Respondents

A total of 397 questionnaires along with samples of pizza and bread were randomly distributed in three supermarkets in the Helsinki area. Completed forms were returned by 355 participants, giving a response rate of 89%. Consumers returning the questionnaire were rewarded with a product package. Three respondents were excluded either because they were under 15 years old or because they lived in the same household as another respondent. Thus, the final number of the respondents was 352, of which 177 had received and 175 had not received the information leaflet.

Of the sample population, 28% were male and 72% female. Seventy-four per cent of the respondents were under 50 years of age and 54% lived in a household of three or more persons. One fourth of the respondents had a primary school education as their highest level of educational attainment and 15% had a university degree.

### 3.2.2 Test food products and packages

The food products selected for the study were pizza with ham filling and sliced rye bread. The samples were packed both with and without an oxygen absorber (App. 1, p. 1/1) and were labelled with compulsory product information (App. 1, p. 1/2). Samples were marked with the letters presented in Table 1. All packages showed only the letter codes and basic product information in order to eliminate the possibility of the answers becoming skewed by the mentioning of the brand and/or manufacturer.

*Table 1. Test food products used in the survey.*

Sample	Food product and weight	Package type and size	Packaging material	Oxygen absorber
<b>K</b>	pizza (ham filling), 200 g	Pouch, 23x21x2 cm	OPALEN 15/30 HL <sup>1)5)</sup>	none
<b>L</b>	pizza (ham filling), 200 g	Pouch, 23x21x2 cm	OPALEN 15/30 HL	Ageless SS 100 <sup>2)6)</sup> (size: 50x45 mm, weight: 2.2 g, oxygen absorption capacity: 100 ml)
<b>M</b>	sliced rye bread, 400 g	Pouch, 22x10x4 cm	OPAE 65 HT <sup>3)5)</sup>	none
<b>R</b>	sliced rye bread, 400 g	Pouch, 22x10x4 cm	OPAE 65 HT	ATCO LH 50 <sup>4)6)</sup> (size: 40x35 mm, weight: 1.2 g, oxygen absorption capacity: 50 ml)

<sup>1)</sup> Manufacturer: UPM Pack (Finland)

<sup>2)</sup> Manufacturer: Mitsubishi Gas Chemical Co., Inc. (Japan)

<sup>3)</sup> Manufacturer: Wihuri Oy Wipak (Finland)

<sup>4)</sup> Manufacturer: Standa Industrie (France)

<sup>5)</sup> Polyamide-polyethylene laminate

<sup>6)</sup> See App. 1, Figs. 3 and 4

The pizza samples were stored at +5 °C after manufacturing. In order to simulate retail conditions, each pizza was illuminated with 1100 ± 300 lux light (Philips TL.W/830, colour: warm white) for 22 ± 2 hours during storage, after which the labels were attached and the samples were stored in the dark. The pizzas had a shelf-life of 14 days at +6 °C, and when the samples were given out, their ‘best before’ date was 3 days away. The bread samples were stored at + 21 °C in a room with a window. The bread had a shelf-life of 5 days and its ‘best before’ date was

2 days after the date the samples were given out.

### **3.2.3 Procedure**

Half of the questionnaires were given out to randomly selected consumers in supermarkets during lunch-time and the rest in the late afternoon. The person mainly responsible for food purchases in the household was asked to fill in the questionnaire. The other recruitment criterion was that either pizza or bread should be regularly used in the household. Consumers were randomly allocated to one of two groups; one group received the information leaflet whereas the other did not receive any information about oxygen absorbers.

### **3.2.4 Questionnaire**

The questionnaire was designed to be self-administered at home. It was developed to guide consumers in the sensory evaluation of samples and to measure consumer attitudes towards oxygen absorbers. A covering letter explaining the purpose of the study and containing answering instructions, a statement of confidentiality, and names of persons to contact if any questions were to arise, was included. The questionnaire was pre-tested on 30 consumers.

#### Part I: Attitudes

The first part of the questionnaire had 29 items for measuring food neophobia (Pliner & Hobden 1992), attitudes towards prepacked food, additives, long shelf-lives and the price/quality relationship in food purchasing situations. Consumers were instructed to indicate on a 5-point bipolar rating scale the extent of their agreement with each statement (endpoints: 1 = disagree, 5 = agree). At the end of this part, there were questions about the appreciated aspects of food packages and



about the frequency of using ready-to-eat foods and bakery products.

### Part II: Sensory evaluation and attitudes towards oxygen absorbers

The second part of the questionnaire contained instructions and questions related to the sensory evaluation of samples. The purpose of the sensory evaluation of samples was to determine whether the use of oxygen absorbers in food packages causes a perceivable difference in sensory characteristics at the end of the regular shelf-life. The order of evaluation was balanced so that every second respondent evaluated first the pizza and bread packed with the absorber. All the respondents evaluated first the pizzas and then the bread. The respondents were asked to complete the evaluation within 48 hours after having received the samples.

The consumers were asked to rate the quality of appearance, odour and flavour and freshness of the samples on a 5-point scale (endpoints: 1 = poor, 5 = excellent). Respondents could choose whether or not to preheat the pizzas before tasting them. The participants were asked to taste the bread with their favourite spread (butter, margarine or spread).

At the end of the second part there were questions aimed at measuring consumer acceptance and attitudes towards oxygen absorbers generally. Space was also provided for comments.

### Part III: Demographics

The third part of the questionnaire consisted of demographic questions, including questions pertaining to gender, age, education, occupation, household composition, special diets and frequency of food purchasing.

### **3.2.5 Sensory evaluation**

In the research institute, a ten-member panel with proven skills and experience in sensory assessment was selected to evaluate the sensory quality of the samples used in the study. The evaluation was administered as a blind test in which the panel members were presented with the samples in a random order with blind codes. The evaluation was performed on the same 5-point scales used by the consumers (endpoints: 1 = poor, 5 = excellent). The pizzas were preheated according to the same heating instructions given to consumers.

### **3.2.6 Statistical analyses**

The data was described by the means of frequency distributions, means, standard deviations and cross-tabulations. Differences in cross-tabulations were tested by Chi-square tests. The differences observed were considered to be almost significant if  $p < 0.05$  (\*), significant if  $p < 0.01$  (\*\*) and extremely significant, if  $p < 0.001$  (\*\*\*)).

Attitude scales were formed from the series of items by recoding the negative items and summing the scores of individual items (App. 2, Table 1). The reliability of these attitude scales was tested by Cronbach's alfa, which measures the response consistency of the items. As a value of  $\geq 0.6$  is considered to indicate a satisfactory consistency (Malhotra 1993), all these scales were reliable (App. 2, Table 2). Respondents were divided into three equal-sized groups according to the strength of their attitudes (App. 2, Table 3). Analysis of variance (one-way) was applied to examine differences in attitudes towards oxygen absorbers among these respondent groups. A comparative analysis of the significance of different means was carried out using the Student-Newman-Keuls test. All analyses were performed using SPSS 6.1 for Windows (Norusis 1993).

## 4 RESULTS

### 4.1 PILOT STUDY

In general, most of the interviewees had a long history of working with foodstuffs and were aware of the current packaging techniques; 81% recognized both vacuum and modified-atmosphere packages. Moisture absorbers, oxygen absorbers and TTIs were the components most familiar to the respondents (recognized by 57%, 52% and 42%, respectively).

Most of the respondents expressed positive attitudes towards components which increase food shelf-life and safety when usage is limited to perishable food. Ready-to-eat foods, vegetables, some bakery products (e.g. toast, 'torn' rye bread and pastry), meat products and packaged fish were mentioned as being such products. The interviewees were unanimous in claiming that consumers prefer high food quality (including purity and safety) over long shelf-lives. Some imported food products may constitute an exception since, in these cases, a longer shelf-life is desirable.

Interviewees considered it important to gain the consumer's trust by giving people objective information about the new technology. They agreed that consumers should be told in explicit terms about the benefits and disadvantages of such components (Table 2). By being open and honest with the facts, consumers' trust in components will increase and unfavourable articles in the tabloid press can be avoided. The respondents considered a thorough study of the environmental impacts of the components to be important. Finnish consumers generally trust the information given by the National Food Administration, Customs Laboratory and the Technical Research Centre of Finland. The interviewees suggested that by establishing a stronger relationship with such organizations, the food industry could use informative marketing based on professionally accredited statements. They also thought that the manufacturers should put an emphasis on training

personnel who work in wholesale and retail outlets, so that proper information could be made available to customers. The respondents believed that informing consumer associations and the media is important, since active public discussion can help consumers to adapt the new technology more quickly.

*Table 2. Interviewees' comments about the benefits (+) offered by the use of components and their disadvantages (-).*

Absorbers/emitters (+):	Absorbers/emitters (-):
<ul style="list-style-type: none"> <li>- hoped for by single-person households</li> <li>- if you want to do your shopping once a week</li> <li>- the food products retain better quality</li> <li>- a broader selection available (import)</li> <li>- prevention of microbiological risks</li> <li>- more positive than additives</li> <li>- the quantity of additives can be reduced</li> <li>- more 'attractive' food</li> <li>- more control over ready-to-eat foods</li> </ul>	<ul style="list-style-type: none"> <li>- fear of foreign substances</li> <li>- people value food produced nearby</li> <li>- more waste</li> <li>- people start eating older food</li> <li>- when the package is opened, it (absorber) stops extending the preservation time</li> <li>- dangerous to children and older people</li> <li>- long shelf-life achieved by packaging technology arouses suspicion</li> <li>- people want to buy fresh food</li> <li>- increases prices</li> <li>- sounds like industry's attempt to sell old food</li> </ul>
Indicators (+):	Indicators (-):
<ul style="list-style-type: none"> <li>- increased safety</li> <li>- chill chain breaks down easily</li> <li>- consumers won't have to just trust their own 'sensory evaluation'</li> <li>- quality can be discovered easily</li> </ul>	<ul style="list-style-type: none"> <li>- something unpredictable could happen, despite of all the security measures taken</li> <li>- there is nothing wrong with the current chill chain</li> <li>- no actual threat of sabotage in Finland</li> <li>- higher prices</li> <li>- more waste</li> <li>- dangerous to children and older people</li> </ul>

The respondents also stated that the package labels should clearly address the purpose and the handling and disposal instructions of the component. The warning "do not eat contents", should be readily visible. The terminology used to describe components is difficult to understand. Components should be named in such way as to clearly indicate their effect on the product. Terms such as indicator, component, ethanol and ethylene might to be too technical in the Finnish language for consumers to properly understand ("Consumers don't want to be chemists").

As a means of providing the necessary information to the consumers in the study, an information leaflet was prepared which answered the questions that commonly arose during the interviews. The information leaflet answered the following questions:

- ◆ What is an oxygen absorber?
- ◆ In what ways do consumers benefit from its use?
- ◆ How does the absorber work?
- ◆ Does removing oxygen from the package have a negative effect on the product?
- ◆ What does the absorber contain?
- ◆ Is something transferred from the absorber to the product?
- ◆ What happens if the absorber is eaten?
- ◆ Can the product be frozen with the absorber?
- ◆ Does the absorber add extra costs to the product?
- ◆ How is the absorber disposed of?

## 4.2 CONSUMER SURVEY

### 4.2.1 Appreciated aspects of food packages

Consumers were asked which aspects they appreciated most in a food package. Of the 19 attributes listed, the respondents were asked to name the 5 most important. The results are presented in Table 3. Overall, consumers rated the communicational and functional characteristics (protection, transparency and 'easy to open') higher than the environmental characteristics.

*Table 3. Most appreciated aspects in food packages (n = 346).*

<b>Packaging attribute</b>	<b>% of respondents</b>
Provides information on the product	86
Protects the product	54
The package is transparent	44
Inexpensive	35
Opens easily	30
Easy to handle	27
Contains a minimum amount of packaging material	27
Recyclable	24
Reusable	23
Can be heated in a microwave	20
Easy to dispose of	19
Provides product with a long shelf-life	18
Closes easily	17
Can be composted	16
Can be refilled	15
Light	14
Pleasant appearance	7
Does not take up much space in the waste basket	6

#### **4.2.2 Sensory quality**

In the case of pizzas, both consumer and laboratory panels noted a significant difference in the appearance, odour and flavour, and freshness in favour of the pizza packed with the oxygen absorber (Table 4). The laboratory panel noted a greater difference than the consumer panel. In the case of rye bread, only the consumer panel noticed a small but statistically significant difference in favour of the sample packed with the absorber. However, the difference was not as great as in the case of pizza. Absolute differences vs. significance levels in the two samples can be explained by the high number of assessors (df = 348 - 350).

Table 4. Results of the sensory evaluation of the consumer (n = 349 - 351) and VTT laboratory panels (n = 10) on a 5-point scale (endpoints; 1 = poor, 5 = excellent). The differences between the mean ratings have been tested by t-test; the significance level is presented in the last column. The differences observed by consumers were all significant, partly as a result of the higher number of assessors (df = 348 - 350).

Consumer panel	Pizza (conventional)		Pizza (absorber)		t-value	df	p
	mean	s.d.	mean	s.d.			
Appearance	3.2	0.8	3.4	0.8	-4.9	350	< 0.001
Odour and flavour	3.2	0.9	3.7	0.8	-10.7	350	< 0.001
Freshness	3.5	0.9	3.9	0.7	-11.1	350	< 0.001
Laboratory panel	Pizza (conventional)		Pizza (absorber)		t-value	df	p
	mean	s.d.	mean	s.d.			
Appearance	3.4	0.8	3.8	0.6	-2.5	9	0.037
Odour and flavour	2.4	0.8	3.8	0.9	-8.6	9	< 0.001
Freshness	2.8	1.0	3.9	0.9	-6.1	9	< 0.001
Consumer panel	Rye bread (conventional)		Rye bread (absorber)		t-value	df	p
	mean	s.d.	mean	s.d.			
Appearance	4.0	0.6	4.1	0.6	-4.3	350	< 0.001
Odour and flavour	3.8	0.8	4.1	0.7	-7.6	349	< 0.001
Freshness	3.9	0.8	4.2	0.7	-9.8	348	< 0.001
Laboratory panel	Rye bread (conventional)		Rye bread (absorber)		t-value	df	p
	mean	s.d.	mean	s.d.			
Appearance	3.9	1.0	4.1	0.6	-0.69	9	0.509
Odour and flavour	3.5	1.0	3.5	0.9	0.00	9	1.000
Freshness	3.5	1.0	3.4	1.0	0.32	9	0.758

About half of the consumers preferred the samples packed with an oxygen absorber to those packed in normal atmosphere (Fig. 1).

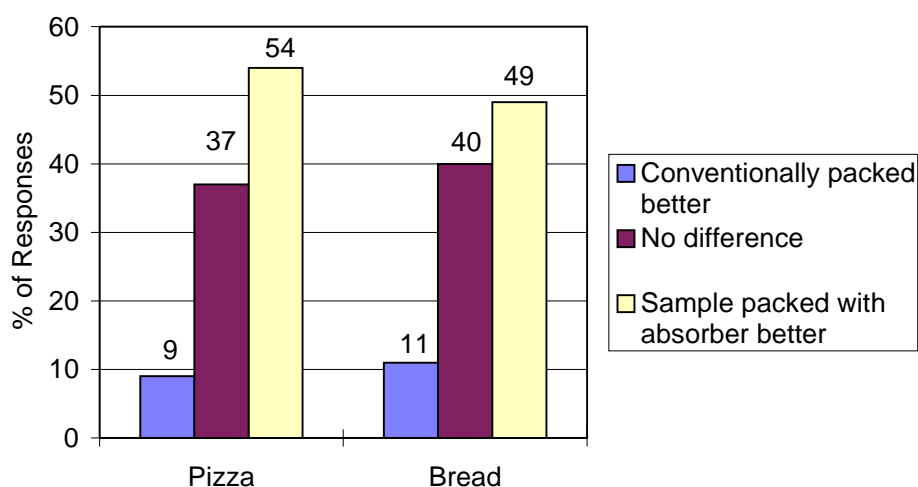


Figure 1. Consumer preference of the samples evaluated (n = 350 - 351).

The consumers were also asked how willing they were to purchase the samples evaluated. As seen from Figure 2, both groups preferred the pizzas packed with absorbers to those packed in a normal atmosphere. In the case of bread, only those consumers who received the information were more willing to buy the sample with the absorber. The results indicate that, given small product differences, consumers who received the information were relatively more willing to choose a sample packed with an oxygen absorber over a conventional one than those who did not receive the information.

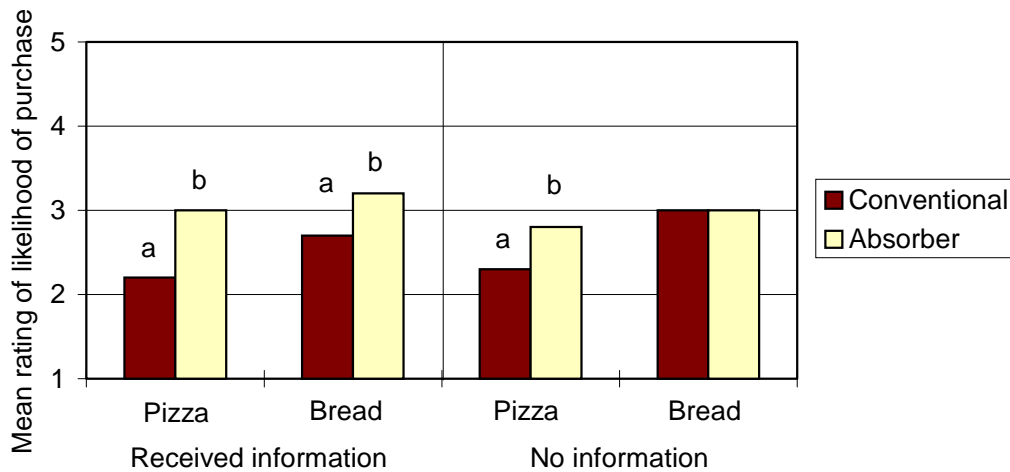


Figure 2. Consumer willingness to buy evaluated samples on a 5-point scale (endpoints; 1 = would not buy, 5= would always buy). Within each pair of bars, mean ratings marked with dissimilar letters differ significantly from each other (*t*-test,  $p < 0.001$ ).

### 4.2.3 Acceptance of the use of oxygen absorbers

Twelve per cent of consumers indicated that they had had prior experience of separate components in food packages. Moisture absorbers used in fresh meat packages and oxygen absorbers in export food products such as tortillas were mentioned. Many consumers also mentioned the small sachets of spice in noodle packages.



When consumers were asked if they accept the application of oxygen absorbers in food packaging, more than 2/3 of respondents gave an affirmative reply (Fig. 3).

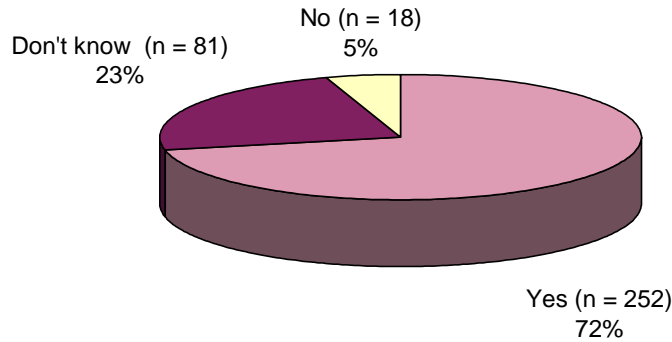


Figure 3. Consumer acceptance of the application of oxygen absorbers in food packaging (n=351).

Consumers who received the information leaflet responded more positively than those who had not been given the information ( $\chi^2 = 4.9$  (df = 1);  $p = 0.03$ ). Those with strong negative views were very few (n = 18) and the information provided did not result in a significant difference in the number of people expressing negative views in the two groups, as presented in Figure 4. Since the size of the ‘not accepting’ group was so small, further comparisons with tests could not be applied to test the effect on the demographics, the attitudes or the packaging preferences.

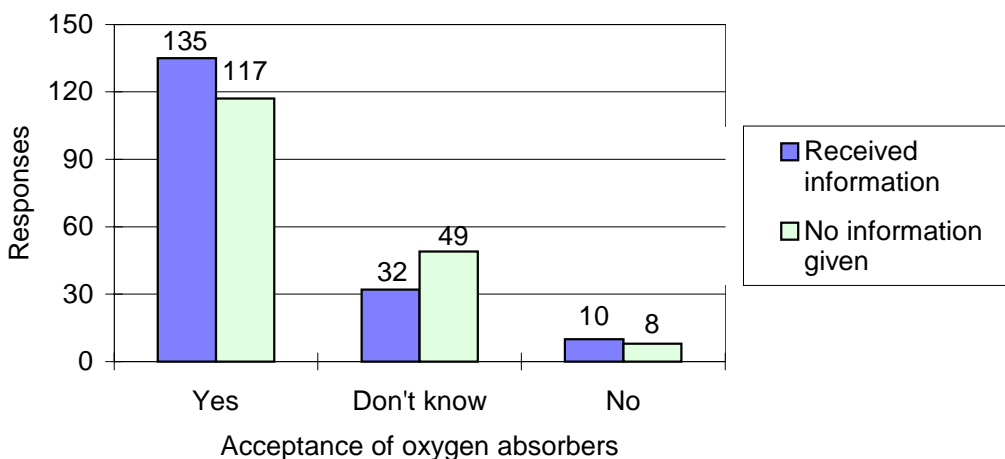


Figure 4. The relationship between consumer acceptance of oxygen absorbers and receiving information. Groups in “yes” and “don’t know” differ from each other significantly ( $\chi^2 = 4.9$  (df = 1);  $p = 0.03$ ).

#### 4.2.4 Attitudes towards oxygen absorbers

Consumers were asked three questions regarding their attitudes towards oxygen absorbers (Table 5). Generally, attitudes were fairly positive. Two-thirds of consumers expressed positive attitudes towards oxygen absorbers, 55% would favour products packed with oxygen absorbers and 49% felt that oxygen absorbers were necessary in food packages. Correspondingly, 8% expressed negative attitudes towards absorbers, 10% would avoid products packed with absorbers and 16% thought that absorbers were unnecessary.

*Table 5. Questionnaire items measuring attitudes towards oxygen absorbers.*

Questionnaire item	response scale	mean	s.d.	n
How do you feel about oxygen absorbers?	1 = negatively; 5 = positively	3.8	0.9	352
How would you react to food products packed with oxygen absorbers?	1 = avoid; 5 = favour	3.6	1.0	352
How necessary do you consider the use of oxygen absorbers in food packages?	1 = unnecessary; 5 = necessary	3.4	1.0	351
General attitude	(range 3 - 15)	10.8	2.8	351

Ratings of the three questions measuring attitude towards oxygen absorbers were summed to form a 'general attitude' measure ( $\alpha = 0.92$ ). Since the respondent was not forced to make a decision between a positive and a negative answer, the general attitude variable can be used in measuring the strength of the attitude.

The relationship between the general attitude and the acceptance is presented in Figure 5. As illustrated, a significant relationship was perceived between acceptance and positive attitudes towards absorbers.

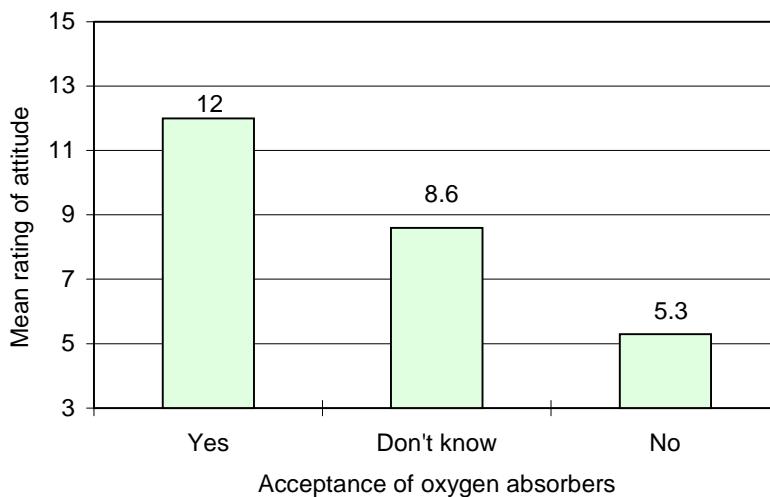


Figure 5. The relationship between consumer acceptance and the general attitude towards oxygen absorbers (range 3 - 15),  $F(2, 347) = 152.7$ ;  $p < 0.001$ .

Receipt of information had no effect on the general attitude towards oxygen absorbers. Among the consumers who received the information, the mean rating of the general attitude was 11.1, and was 10.7 in case of those who did not receive the information ( $F(1, 349) = 1.5$ ;  $p = 0.227$ ). Still, as presented earlier in Figure 4, consumers who received the information sheet were more willing to accept the use of absorbers. In conclusion, in a forced choice situation, the information facilitated the acceptance of oxygen absorbers even given a positive initial attitude.

#### 4.2.5 Factors influencing attitudes

##### Demographics

Gender, age, education, household size or other demographic factors were not observed to have a significant effect on consumer attitudes towards oxygen absorbers (App. 3). Also, no significantly different reactions to the information provided were observed among the groups.

Attitudes towards new foods, food packaging, additives, long shelf-lives and the importance of the price/quality relationship

Overall, respondents' attitudes towards new foods were fairly positive since the mean rating was clearly below the midpoint of the food neophobia scale (App. 2, Table 1). The respondents also favoured unpacked food, had quite negative attitudes towards additives and valued high quality more than low price.

Consumer attitudes towards prepacked food, additives and a long shelf-life were related to the general attitude towards oxygen absorbers (Figure 6). Consumers opposed to food packaging and a long shelf-life also expressed a less favourable attitude towards oxygen absorbers. Correspondingly, consumers who accepted the use of additives also expressed more favourable attitudes towards oxygen absorbers. The attitudes towards new foods (food neophobia) and the importance of the price/quality relation in food purchasing situations had no significant influence on the general attitude.

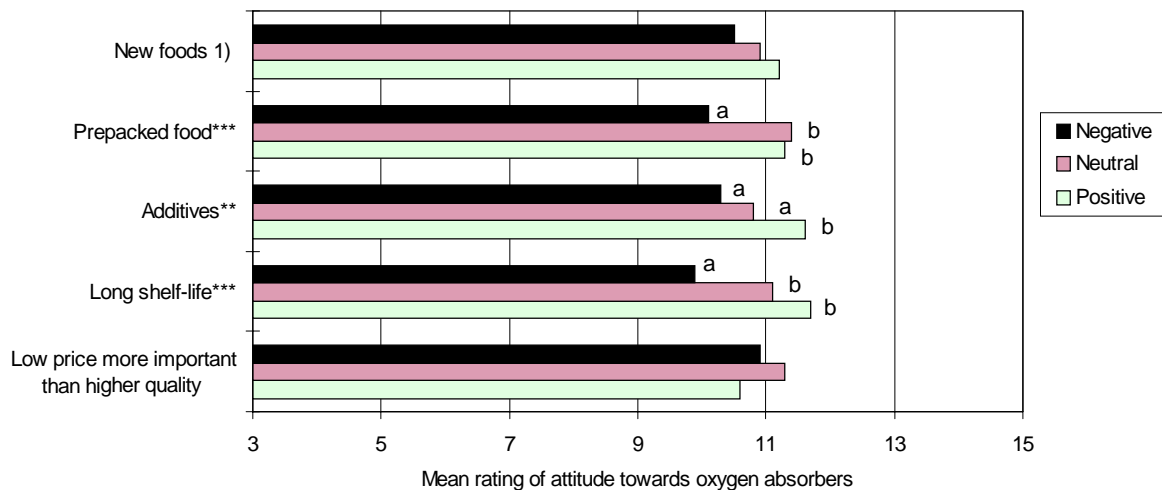


Figure 6. The relationship between other measured attitudes and the general attitude towards oxygen absorbers (range 3 - 15). Within each group of bars, mean ratings marked with dissimilar letters differ significantly from each other (Student-Newman-Keuls test, \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ).

<sup>1)</sup> To ease the presentation of the scales, variable “neophobia” was recoded and named “new foods”. The most neophobic respondents can thus be found among the consumers expressing negative attitudes towards new foods (group “negative”).

### Frequency of using ready-to-eat foods and bakery products

Consumers were asked to rate how often they use certain ready-to-eat foods and bakery products, in order to find out whether their use is related to attitudes towards oxygen absorbers. Participants frequently using pizza and sliced rye bread also expressed more positive attitudes towards oxygen absorbers than non-users (Figures 7a and 7b). A similar relationship could be perceived between frequent users and non-users of prepared casseroles and pastry ( $p < 0.05$ ).

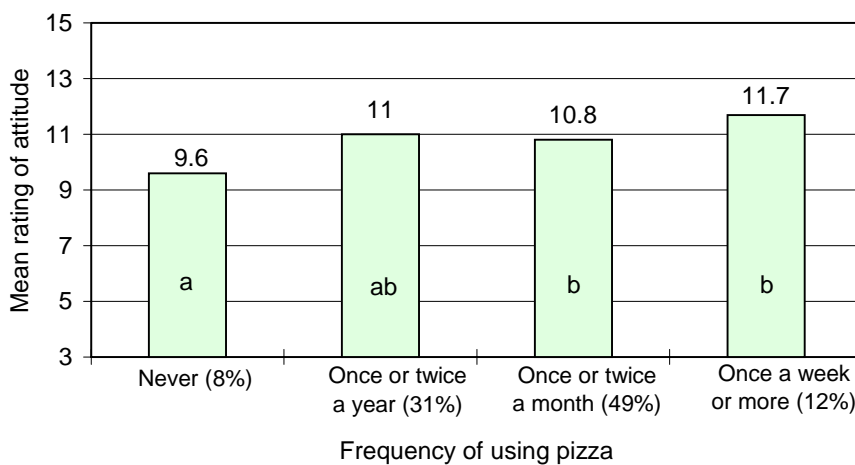


Figure 7a. The relationship between the general attitude and frequency of using pizza (range 3 - 15),  $F(3,347) = 3.3$ ;  $p = 0.021$ . Mean ratings of bars marked with dissimilar letters differ significantly from each other (Student-Newman-Keuls test,  $p < 0.05$ ).

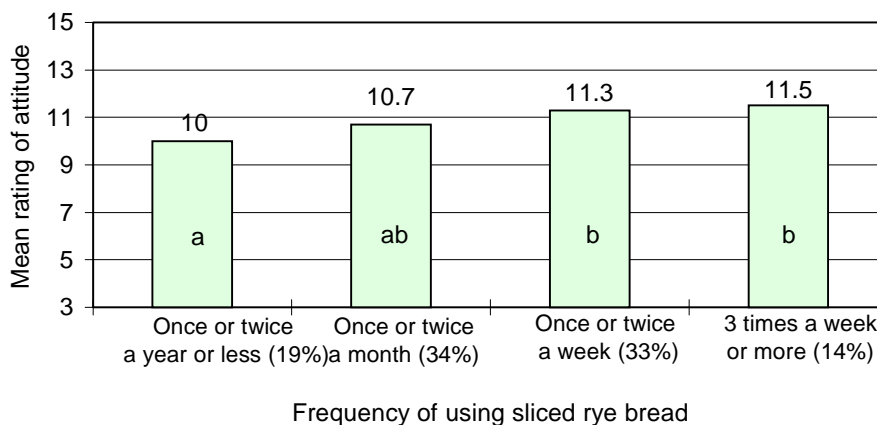


Figure 7b. The relationship between the general attitude and frequency of using sliced rye bread (range 3 - 15),  $F(3,345) = 3.8$ ;  $p = 0.010$ . Mean ratings of bars marked with dissimilar letters differ significantly from each other (Student-Newman-Keuls test,  $p < 0.05$ ).

#### 4.2.6 Acceptance of oxygen absorbers in different food products

Consumers were asked whether they would approve of the application of oxygen absorbers in the different types of food product presented in Table 6. Respondents were most in favour of oxygen absorbers used in the sample foodstuffs (pizza 62% and bread 57%), perhaps due to the realistic product display. Correspondingly, the use of absorbers in fresh meat was met with the greatest opposition on the part of consumers.

*Table 6. Acceptance of the application of oxygen absorbers in different foodstuffs (n = 331).*

Acceptance (%)	Yes	No
Ready prepared food/meat products		
Pizzas	62	9
Meat balls	48	17
Sausages	37	26
Cold cuts	34	30
Fresh meat	29	37
Bakery products		
Rye bread	57	16
Toast	55	15
Unleavened bread	55	18
Diet products	50	12
Pastry	50	21
Other		
Spices	48	23
Peanuts	41	23
Chocolates	38	27

#### 4.2.7 Willingness to pay extra for oxygen absorbers

When asked if consumers would be prepared to pay more for products packed with oxygen absorbers, 40% said they would pay more. Of these, 70% were prepared to pay 10 pennies (FIM 0.1) more, 19%, 20 pennies more and 11%, 30 pennies more than for a normal product. Consumers who accepted the use of oxygen absorbers were also most willing to pay more for products with absorbers (Fig. 8). Receiving information did not influence the consumer's willingness to pay extra.

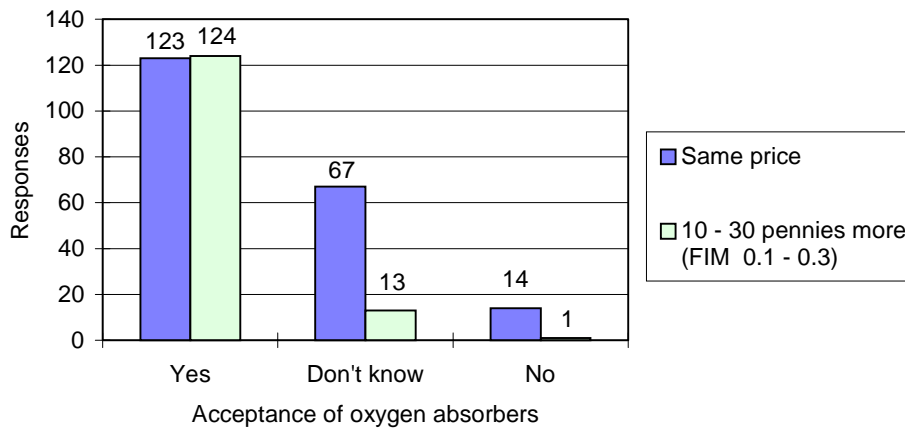


Figure 8. The relationship between consumer acceptance of and willingness to pay extra for oxygen absorbers,  $\chi^2 = 36.3$  ( $df = 2$ );  $p < 0.001$ .

#### 4.2.8 Consumer comments

Many consumers commented upon the oxygen absorbers in the ‘space for comments’ section. Consumers receiving the information sheet mentioned the possibilities of preventing the absorber from falling into the possession of children or pets. Some consumers also thought that the information written on the absorber sachet (e.g. “do not eat”) was not clear enough. An extensive information campaign was considered important to facilitate the acceptance of the new technology by consumers. Reducing the amount of additives used in food products was regarded as the absorber’s major advantage, whereas waste and a perceived ‘harmful substance’ were their major disadvantages.

Many consumers who did not receive any information, said that they wished to know more about the absorbers before they would make a decision whether or not to accept the use of oxygen absorbers. Many of them also presented the same questions that are already answered in the information leaflet (e.g. what does the absorber contain, are any substances absorbed into the product, and is it dangerous). They also commented on the appearance of the sachets (that absorbers should be made to stand out in order to prevent misuse) and the possibility of it breaking up inside package.

## 5 DISCUSSION AND CONCLUSIONS

Introducing a new technology to the market is never easy. Almost without exception, it takes a lot of time and persistent effort to raise consumer awareness and to bring about acceptance. For example, according to a US study in 1984, only 23% of consumers had heard of the process of irradiation (Anon. 1984). The corresponding percentage was 60% in a nation-wide survey conducted in 1989 (Schultz *et al.* 1989). According to the latest survey conducted in 1994, awareness had increased to 72%, with 88% of these respondents indicating that they had heard of irradiation but did not know that much about it (Resurreccion *et al.* 1995). According to the same study, 45% of the respondents indicated that they would buy irradiated food, 19% indicated that they would not buy it, and the remainder had not made up their mind.

Consumers in the present study were open to the idea of using oxygen absorbers in food packages, although for many it was their first exposure to such a technology. It is important to remember, however, that this study was conducted in the Helsinki area, which is inhabited by 20% of Finland's total population of 5 million. The responses may have been different, had this study been carried out elsewhere in Finland, given that the consumption patterns of residents in the capital area are likely to be different from those living in the countryside. Whether these results are applicable to other European countries remains to be tested. The interviews which preceded the consumer survey were found to be useful since the consumer information providers were well aware of current consumer concerns and had experience in popularizing a difficult subject. A similar approach is recommended if such a study is to be carried out elsewhere in Europe.

The results of the present study suggest, that the use of an absorber is not justifiable on the basis of extended shelf-life, but because of superior quality and the maintenance of product freshness. Information provision was found to help bring about consumer acceptance of oxygen absorbers. Consumers that had access to the



information were more willing to choose a product packed with an absorber over a conventional product than those who did not receive any information.

Acceptance of absorbers was enhanced by direct experience with foods. In those food products, that were used as sample foods, were oxygen absorbers accepted better than in other food products belonging to the same food categories. Correspondingly, the resistance towards using absorbers in meat suggests that consumers want to buy their meat fresh.

The respondents of this study rated communicational and functional criteria higher than environmental criteria in case of food packaging. In a Danish study by Bech-Larsen (1996), the response was found to be similar. Out of a total of 273 respondents surveyed, 29% mentioned functional, 10% communicative and 7% environmental criteria in packaging as being important in food purchasing situations. Four out of ten respondents in the present study were willing to pay more for a product packed with an oxygen absorber. In addition, the British National Consumer Council (Anon. 1991) found 60% of respondents to be prepared to pay more for products packed with time-temperature indicators.

To conclude, oxygen absorbers may have a future in food packaging in Finland. The results suggest that an oxygen absorber may be considered a competitive option when considering the extension of product shelf-life through packaging technologies. Nevertheless, the improved safety of oxygen absorbers achieved by replacing loose sachets with stickers or through oxygen absorbers attached to the packaging material including developing more 'environmentally friendly' applications, are all likely to further increase consumer acceptance.

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OXYGEN ABSORBERS AND FOOD SAMPLES USED IN THE STUDY



Figure 1. Oxygen absorber used in pizza (Ageless SS 100).



Figure 2. Oxygen absorber used in bread (ATCO LH 50).



Figure 3. Pizza samples used in the study.



Figure 4. Bread samples used in the study.

## ATTITUDE SCALES USED IN THE STUDY

*Table 1. Mean ratings of the attitude variables (n = 347 - 350). The theoretical range consists of minimum and maximum rating of each set of items i.e. when the neophobia variable consisted of 10 items presented on a 1-5-scale, the minimum rating would be 10 and the maximum 50. The observed range indicates which parts of the range were used.*

	Number of items	Theoretical range		Observed range		Mean	s.d.
		min	max	min	max		
Neophobia	10	10	50	10	44	22.1	7.3
Prepackaged food	4	4	20	4	20	9.1	3.4
Additives	6	6	30	6	30	16.6	4.8
Long shelf-lives	4	4	20	4	20	12.2	4.1
Low price/high quality	5	5	25	5	25	13.0	3.8

*Table 2. Reliability of the attitude variables.*

	Cronbach's $\alpha$
Neophobia	0.82
Prepackaged food	0.73
Additives	0.74
Long shelf-lives	0.79
Low price/high quality	0.64

*Table 3. Ranges of each attitude group (n = 347 - 350). To ease the presentation of the scales, variable "neophobia" was recoded and named "new foods", so that the most neophobic respondents can be found among the consumers expressing negative attitudes towards new foods (group "negative").*

	Negative		Neutral		Positive	
	range	% of resp.	range	% of resp.	range	% of resp.
New foods	16 - 35	32	36 - 41	34	41 - 50	34
Prepackaged food	4 - 7	37	8 - 10	30	11 - 20	33
Additives	6 - 14	34	15 - 18	32	29 - 30	34
Long shelf-lives	4 - 10	37	11 - 14	30	15 - 20	33
Low price/high quality	5 - 11	38	12 - 14	30	15 - 25	32

APPENDIX 3

THE RELATIONSHIP BETWEEN DEMOGRAPHICS AND GENERAL ATTITUDE TOWARDS OXYGEN ABSORBERS

*Table 1. The relationship between gender and mean rating of general attitude towards oxygen absorbers (n = 350). Range 3 - 15 (3 = negative, 15 = positive).*

Male (28%)	Female (72%)	F-value	df	p
11.2	10.7	1.7	1, 348	0.199

*Table 2. The relationship between age and mean rating of general attitude towards oxygen absorbers (n = 348). Range 3 - 15 (3 = negative, 15 = positive).*

15-29 (20%)	30-44 (43%)	45-59 (27%)	60 and over (10%)	F-value	df	p
11.0	10.9	10.7	10.9	0.1	3, 344	0.952

*Table 3. The relationship between highest level of education and mean rating of general attitude towards oxygen absorbers (n = 347). Range 3 - 15 (3 = negative, 15 = positive).*

Primary/vocational school (41%)	Upper secondary/college (44%)	University degree (15%)	F-value	df	p
10.9	10.9	10.8	0.1	2, 344	0.943

*Table 4. The relationship between household size and mean rating of general attitude towards oxygen absorbers (n = 350). Range 3 - 15 (3 = negative, 15 = positive).*

1 person (11%)	2 persons (35%)	3 persons and over (54%)	F-value	df	p
10.1	10.9	11.0	1.8	2, 347	0.168