# Investigación preliminar de la influencia del tratamiento térmico y tiempo de almacenamiento sobre el aroma de habas (*Vicia faba*)

## Preliminary investigation on the influence of heat treatment and storage time on the aroma of faba beans (*Vicia faba*)

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Jose Ramos-Díaz[1,2], Sonja Suvanto[1], Elina Forsten[1], Laila Seppa[1]

## Abstract

Faba bean (*Vicia faba*) is a legume available in Finland that is used in human and animal consumption due to its high content of protein and fiber. Unlike other legumes, little is known about the aroma volatiles developed by faba beans in storage, and the descriptors associated to it. Suspensions containing heat treated (H) and non-heat treated (NH) faba bean samples were stored at 4 °C for 0, 7 and 14 days, and evaluated with descriptive analysis. The training sessions encouraged the elicitation of aroma descriptors linked to faba bean. The final attributes were: fresh pea, musty, bitter, grassy, yeast-like and total intensity. Faba bean suspensions (H and NH) were also analysed for volatile compounds using SPME-GC-MS. The results indicated that the intensity of total intensity, yeast-like, bitter and musty increased at the longest storage time regardless of the heat treatment. In contrast, fresh pea and grassy appeared to reach a peak at 7-day storage. Statistical results suggested heat treatment had a much lesser effect on aroma development than storage time. The analysis of volatile compounds showed that 2-butanone-3-hydroxy and 3-methyl-1-butanol had the most prominent peak areas at 7 and 14-day storage (particularly for NH). H and NH samples were associated to almost the same volatile compounds until the 7 day and linked to distinct compounds by the end of the storage. It is believed that fresh pea and grassy are strongly associated to ketones present in H and NH samples at 7-day storage while musty, bitter and yeast-like are more associated to alcohols and ketones present in NH samples at 14-day storage.

*Keywords:* Faba beans, aroma, volatile compounds, storage, gas chromatography

## Resumen

Haba (Vicia faba) es una leguminosa disponible en Finlandia que se utiliza en la alimentación humana y animal debido a su alto contenido de proteína y fibra. A diferencia de otras legumbres, poco se sabe acerca de las sustancias volátiles que se producen durante el almacenamiento y los descriptores de aroma asociados a las mismas. durante el almacenamiento y los descriptores de aroma asociados a las mismas. Las suspensiones fueron elaboradas en base a harina de habas. Muestras fueron sometidas a tratamiento térmico (T) y mantenidas sin tratamiento térmico (ST). Estas fueron almacenadas a 4 ° C durante 0, 7 y 14 días. Los panelistas que participaron en el estudio sensorial fueron ocho mujeres (n = 8) entre 25 y 55 años de edad. Las sesiones de entrenamiento alentaron a la obtención de los descriptores aromáticos vinculados al haba: 'guisantes frescos', 'rancio', 'amargo', 'herboso', 'levadura' y la intensidad total. El análisis sensorial se llevó a cabo por duplicado con una recesión de 30 minutos en el medio. También se analizaron las suspensiones de habas (T y ST) para compuestos volátiles utilizando SPME-GC-MS. Los resultados indicaron que la intensidad total, levadura, amargo y rancio aumentó durante almacenamiento prolongado, independientemente del tratamiento térmico. En contraste, el aroma a guisante fresco y herboso parecían alcanzar un pico en el almacenamiento 7mo día. Los resultados estadísticos sugirieron que el tratamiento térmico tuvo un efecto mucho menor en el desarrollo del aroma que el tiempo de almacenamiento. El análisis de compuestos volátiles mostró que 2-butanona-3-hidroxi y 3-metil-1-butanol tenían las áreas de los picos más prominentes al 7mo y 14vo día de almacenamiento (especialmente para ST). Muestras T y ST se asociaron a casi los mismos compuestos volátiles hasta el 7mo día, y después se vincularon a distintos compuestos al final del almacenamiento. Se cree que los aromas a guisante fresco y herboso están fuertemente asociados a cetonas presentes en muestras T, y muestras ST al 7mo día de almacenamiento, mientras que rancio, amargo y levadura están más asociados a los alcoholes y cetonas presentes en las muestras ST al 14vo día de almacenamiento.

*Palabras clave:* habas, aroma, compuestos volátiles, almacenamiento, cromatografía de gases

1 Department of Food and Environmental Sciences, PO Box 66 (Agnes Sjöbergin katu 2) FI-00014 University of Helsinki, Finland
2 *E-mail:* jose.ramosdiaz@helsinki.fi

## INTRODUCTION

Legumes are nutritious food alternatives for humans (Tiwari, Gowen, & McKenna, 2011). They contain essential amino acids, fatty acids, vitamins, minerals, carbohydrates and fiber. Legumes include a large number of different beans, which are able to grow in difficult conditions. Its advantage over other plants is their ability to fix nitrogen from the soil (formation of ammonia from molecular nitrogen). Faba beans (Vicia faba) are one of the crops that are better adapted to the Nordic climate (Peltonen-Sainio and Niemi, 2012).

Generally, faba beans are used in whole-grain products, but their technological use increased considerably since early 2000s (Makri, Papalamprou, & Doxastakis, 2005). The use of vegetable proteins as functional components in food is limited (almost entirely) to soybeans, whose nutritional content is similar to any other legume. Promoting the efficient use of alternative legumes, and studying their technological and sensory properties have become a scientific challenge.

The particular aroma of legumes limits their use in the Western world (Vara-Ubol, E. Chambers, & D. Chambers, 2004). For instance, the flavor generated by the oxidation of unsaturated fatty acids during processing and storage, and/or the degradation of amino acids during heat treatment result in the release of volatile compounds of potential unpleasant aroma (Rodríguez-Bernaldo De Quirós, López-Hernández, González-Castro, De La Cruz-García, & Simal-Lozano, 2000). Bott and Chambers (2006) found two separate volatile compounds that have no beany flavor, but as a whole generated the characteristic faba bean aroma. Vara-Ubol et al. (2004) had a trained panel ($n$ = 5) to evaluate the aroma and taste of different varieties of canned and dried faba beans. Aroma and taste as a whole were described with the words: 'stale', 'humidity', 'bitter', 'green', 'nut' and 'starch'. The structure was described as 'flour-like'. Certain volatile compounds such as alcohols, ketones, aldehydes, and pyrazine contributed to aroma and taste of the samples. The authors also found that the concentration of volatiles was relevant. Many compounds, produced in small amounts, contributed to the aroma or taste as a whole, but such effect was lost at higher concentrations.

As descriptors for faba beans are hardly found in the literature, the aim of this work was to create a descriptive profile of the aroma for faba bean suspensions (in water), and test the effect of heat treatment and storage time on the aroma and intensity. The correlation between volatile aromatic compounds present in the samples, and the aromas described by the panellists will also be studied. The work was done in collaboration with the Department of Food and Environmental Sciences at the University of Helsinki.

## METHOD

### Materials

Faba beans (*Vicia Faba* var. Kontu 2012) used in this study were harvested from the teaching and research farm of Helsinki University in Viikki. Faba beans were divided into two groups: heat treated (H) and non-heated treated (NH) samples. The H samples went through moisture adjustment to 10% followed by 30-min stabilization time. These samples were heated at 140 °C for 20 min and then stored overnight at 40 °C. Eventually, H and NH samples were dehulled, milled and stored at room temperature prior to the preparation of suspensions. These suspensions were elaborated by placing 20 g of H or NH samples in a 150-ml vial followed by the addition of 100 ml water. This mixture was first stabilized for 30 min and then centrifuged for 15 min at 10000 rpm. The supernatant was poured in a 200-ml flask, sealed and stored in darkness at 4 °C for 0, 7 and 14 days. Suspensions were prepared in the Cereal Technology laboratory at University of Helsinki. The process is shown in Figure 1.

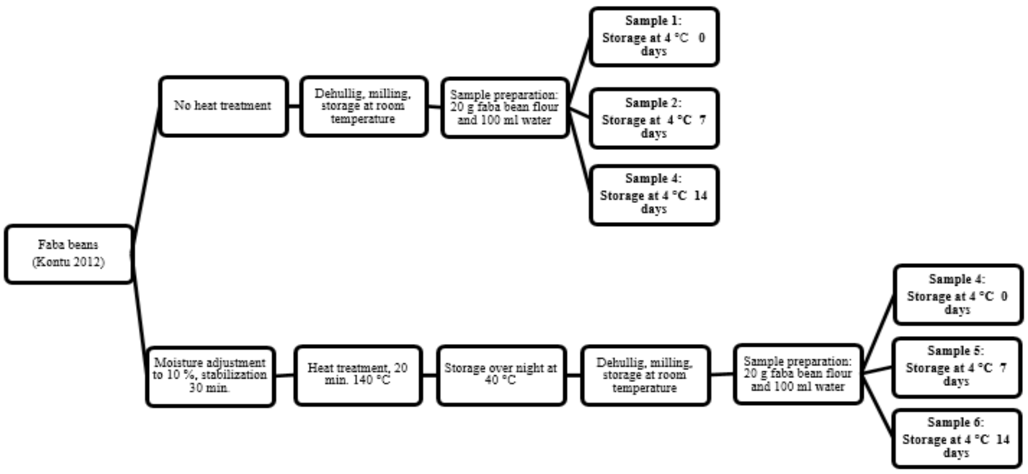



*Figure 1.* Flow chart for the preparation of faba bean suspensions.

## Methods

### Training of panellists

The panellists involved in the study were 8 women ($n$ = 8), aged between 25 and 55 years old (staff and students). Most of them had taken part in sensory testing before, and were familiar with faba bean. The training sessions were held in Finnish at the food sensory laboratory of Department of Food and Environmental Sciences. This study followed the approved ethical requirements of the University of Helsinki, and an informed consent was signed by the participating panellists. Two training sessions (2.5 h in total) were arranged prior to the sensory test. During the first session (90 min), panellists were presented with a series of hulled faba bean suspensions as references (Table 1). They described the samples independently and then discussed with the rest of the panel. A list of descriptors was presented (Appendix 1) so as to help panellists to form a concept around the aroma characteristics of H and NH faba bean suspensions. At first, panellists came up with a large number of descriptors (Appendix 2) which eventually narrowed down to 6 (Table 2), including 'total intensity'.

Table 1
*List of reference samples used for both training days*

| Reference sample | Manufacturer | Sample size | Container |
|---|---|---|---|
| 7-day H hulled faba bean susp. | Food Tech. Lab. at UH | 15 ml | Laboratory bottles |
| 14-day H hulled faba bean susp. | Food Tech. Lab. at UH | 15 ml | |
| 7-day NH hulled faba bean susp. | Food Tech. Lab. at UH | 15 ml | |
| 14-day NH hulled faba bean susp. | Food Tech. Lab.at UH | 15 ml | |

| | | | |
|---|---|---|---|
| Yeast | Suomen Hiiva | 50 g | Porcelain containers |
| Soil with water | Food Tech. Lab.at UH | 50 g | |
| Fresh green peas | Apetit | 100 g | |
| Soaked peas | Food Tech. Lab.at UH | 150 g | |
| Almonds | Kluth | 50 g | |
| Cashew nuts | Kluth | 50 g | |
| Brazilian nuts | Kluth | 50 g | |
| Hazelnuts | Kluth | 50 g | |
| Hexanal | Food Tech. Lab.at UH | 50 g | |
| Fresh mushroom | X-tra | 50 g | |
| Dried mushroom | Self-collected | 50 g | |
| Dried black chanterelle | Self-collected | 50 g | |
| Dried funnel chanterelle | Self-collected | 50 g | |

*Note*: Sample containers were covered by a plastic foil.

During the second training (60 min), the actual faba bean suspensions were revealed as such so that panellists could attempt to describe their odours with the help of the descriptors chosen by consensus during the first training. There were, however, changes in the vocabulary such as the addition of 'yeast-like' and the withdrawal of 'toasty' and 'peanut'. The final set of the descriptors associated to the odour of H and NH faba bean suspensions are detailed in Table 2.

Table 2
*Descriptors chosen by consensus during the first and second training*

| First training – Ensimmäinen koulutus | Second training – Toinen koulutus |
|---|---|
| Fresh pea – tuorehernemäinen | Fresh pea – tuorehernemäinen |
| Musty – ummehtunut | Musty – ummehtunut |
| Bitter – kitkerä | Bitter – kitkerä |
| Toasty – paahteinen | **Withdrawn** |
| Grassy – ruohomainen | Grassy – ruohomainen |
| Peanut – pähkinäinen | **Withdrawn** |
| | Yeast-like – hiivamaine |
| Total intensity – Kokonaisvoimakkuus | Total intensity – Kokonaisvoimakkuus |

*Note:* The training was originally conducted in Finnish language.

**Sensory profiling**

The data collection method was generic descriptive analysis as described by Lawless and Heymann (2010). The descriptors were introduced in Fizz® software (version 2, Biosystèmes, Couternon, France) for computer-based testing. A 15 cm magnitude line scale with indented end-anchors lines on either side was used. For 'total intensity', labels endpoints were 'not strong at all' (ei lainkaan voimakas) and 'extremely strong' (erittäin voimakas) while for the rest of the attributes, labels endpoints were 'not at all' (ei lainkaan) and 'extremely' (erittäin). Coded samples were randomized across trials. Panellists were first presented with one set of samples (3 H samples and 3 NH samples, corresponding each to 0, 7 and 14-day storage) and, after a 30-min recession, with a second set of samples (duplicate).

**Analysis of volatile compounds**

Faba bean suspensions (H and NH) at different storage times (0, 7 and 14 days) were analysed for volatile compounds by using SPME-GC-MS. Solid-phase micro extraction (SPME) was tested with Divinylbenzene / carboxen / polydimethylsiloxane fiber (DVB/CAR/PDMS 50/30 µm) (Supelso, USA) by using an auto sampler system (combiPAL, CTC Analytics). The sample (2 ml) was incubated in a 20 ml vial with pierceable silicon/Teflon disks in the cap. The fibers were directly desorbed at 250 °C (DVB/CAR/PDMS) for 10 min in the injection port of GC. The GC-MS system consisted of a GC (HP 6890 series) linked to a mass selective detector (MS) (Agilent 5973 Network). The GC was equipped with a SPB-624 column (Supelco, Bellefont PA, USA) (30 m x 0.25 mm i.d., 1.4 µm film thickness). The following parameters were selected for the SPME-GC-MS method: fiber DVB/CAR/PDMS 50/30 µm; incubation at 50 °C for 20 min; extraction at 50 °C for 30 min. The GC programme started at 35 °C for 5 min, increased 3 °C/min until 150 °C, held for 1 min, increased 6 °C/min until 200 °C and held for 5 min.

**Statistical analysis**

The resulting data was statistically analysed by using a three-way repeated-measures ANOVA in SPSS (SPSS 18.0, PASW Statistics, Chicago, IL, USA). Factors were heat treatment (number of factors 2), storage time (3) and replicates (2). Fisher's LSD test with significance level of 5% was used for pairwise comparisons. Principal component analysis (PCA) plots were used to identify the most important directions of variability of different samples in a multivariate data matrix (The Unscrambler v9.7; CAMO Software AS, Oslo, Norway); correlations among descriptors and volatile compounds were identified.

## RESULTS

*Aroma characteristics of the suspensions and intensity*

Aroma intensity increases with increasing length of storage, both in H and NH samples. Similarly, yeast-like, musty and bitter aromas were perceived more intensely at longer storage periods. Grassy and fresh pea reached their greatest perceivable intensity at 7-day storage. Means and standard deviations are shown in Figure 2, and the effect of heat treatment and storage time on aromas in Figure 3. The standard deviation was relatively high in all results. It was observed that H and NH samples had similar aroma to fresh peas, yeast-like and total intensity before storage (0-day storage). The NH samples stored for 0 and 7 days possessed a stronger faba bean aroma than H samples. Regardless of the treatment, samples stored for 7 days elicited the strongest grassy aroma. After 14-day storage, H and NH samples possessed yeast-like, musty and bitter aroma. The same observations can be made based on PCA.

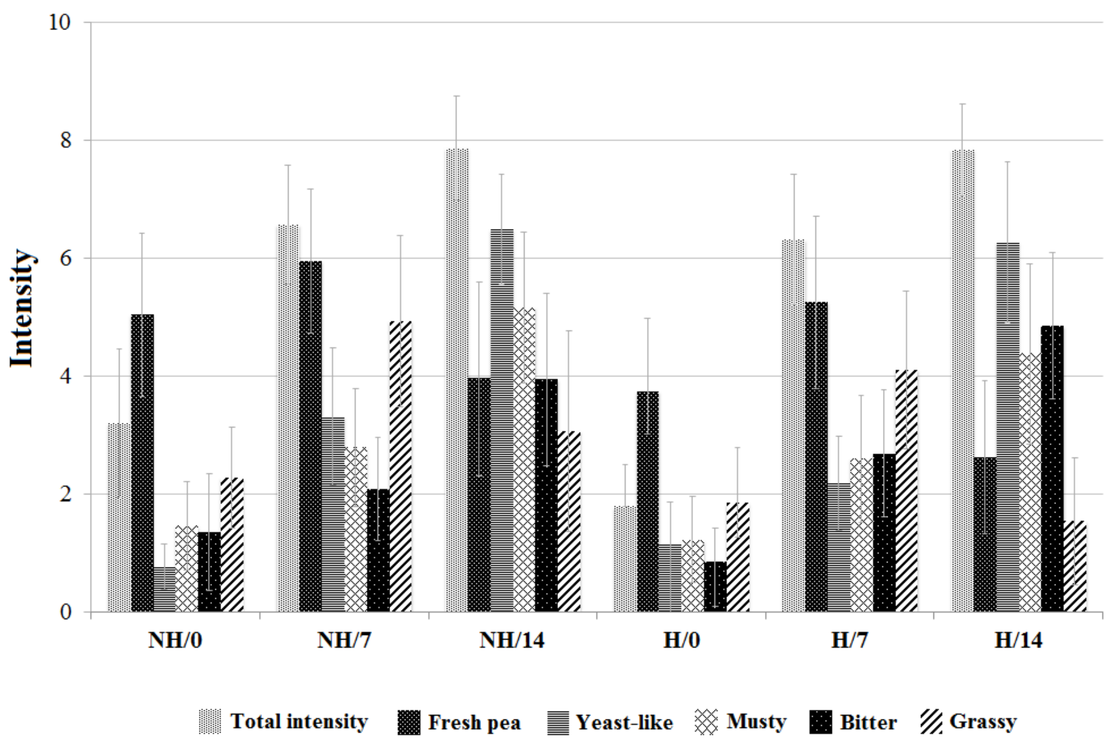
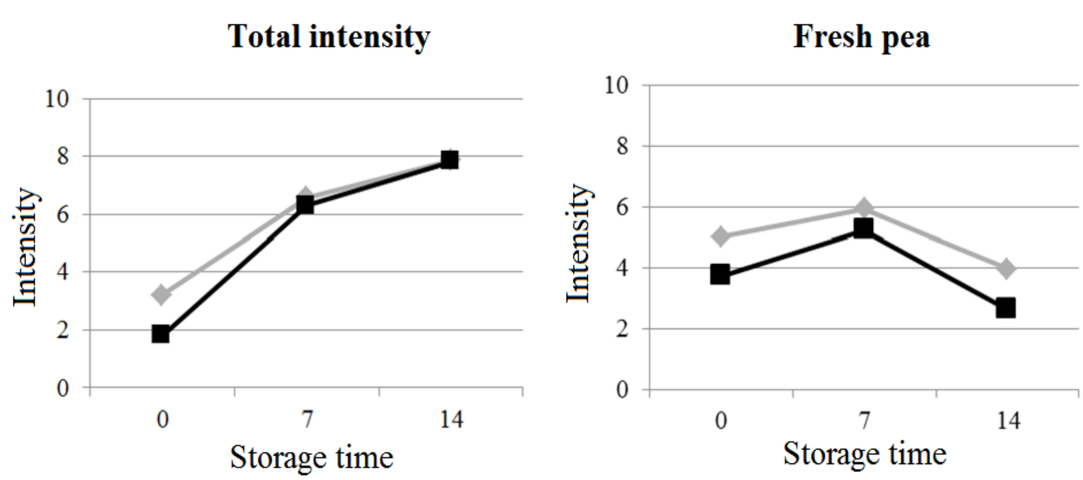



*Figure 2*. The averages of the every perceived aroma characteristics of faba bean suspensions subjected to different heat treatments and storage times. ST = No heat treatment; T = Heat treatment; 0, 7, 14 days of storage. Error bars show ±1 SD. n=8



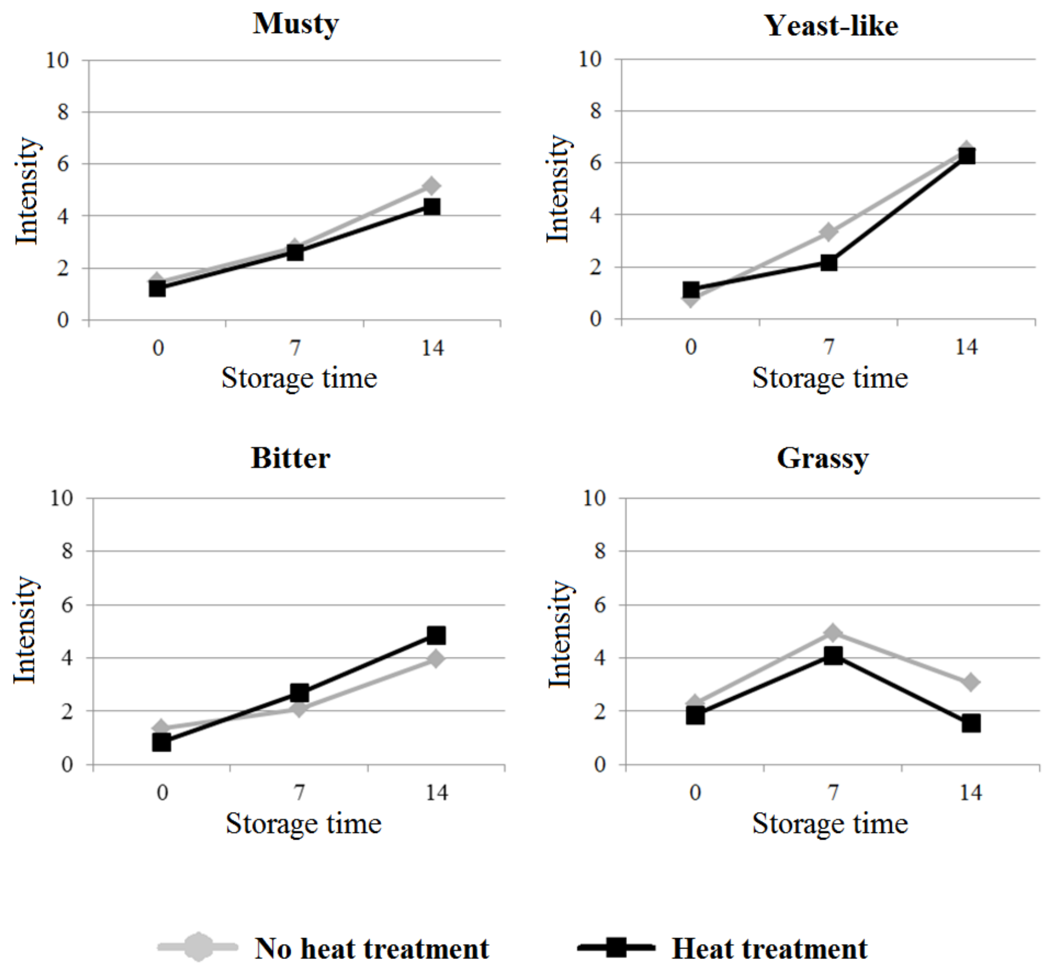



*Figure 3*. Effect of heat treatment and storage time on perceived aromas. The experiment was conducted in duplicate.
*$n$ = 8.

The heat treatment and storage time affected significantly [main effect of heat treatment, F (1, 7) = 13.1, p=0.008; main effect of storage time, F (2, 6) = 28.4, p=0.001] the perceived total intensity. The heat treatment and storage time had also a considerable effect on the aroma of fresh pea [main effect of heat treatment, F (1, 7) = 6.3, p=0.04; main effect of storage time, F (2, 6) = 6.4; p=0.03] and grassy [main effect of heat treatment, F (1, 7) = 17, p=0.004; main effect of storage time, F (2, 6) = 6.4; p=0.03]. It seems that storage time increased distinctively the yeast-like [main effect of storage time, F (2, 6) = 20.9; p=0.002] and bitter aroma [main effect of storage time, F (2, 6) = 12.3; p=0.007]. Regardless of the treatment, the musty aroma increased considerably between 7 and 14 days of storage (pairwise comparison; p=0.015).

The replicate of the evaluation had no significant effect on the aroma intensity or any individual aroma. This means that, in general, panellists evaluated samples reliably and accurately. However, storage time and replicate had a significant interaction effect [F (2, 6) = 6.4; p=0.03] on musty aroma. Besides, the interaction of heat treatment and storage time had a significant effect [F (2, 6) = 9.1; p=0.01] on yeast-like aroma. This means that the effect of storage time on the yeast-like aroma changed depending on the heat treatment.

### Principal component analysis

Based on the PCA, two principal components explained 97% of the observed variation in the aroma characteristics of the samples (Figure 4). The first principal component explained 66% of the variation and the second 31%. Samples with different storage times (0, 7 and 14 days) showed a higher variation along the first principal component (66% variation). Conversely, the heat treated samples showed no significant differences, and these appear to be better explained by the second main component (31% variation).

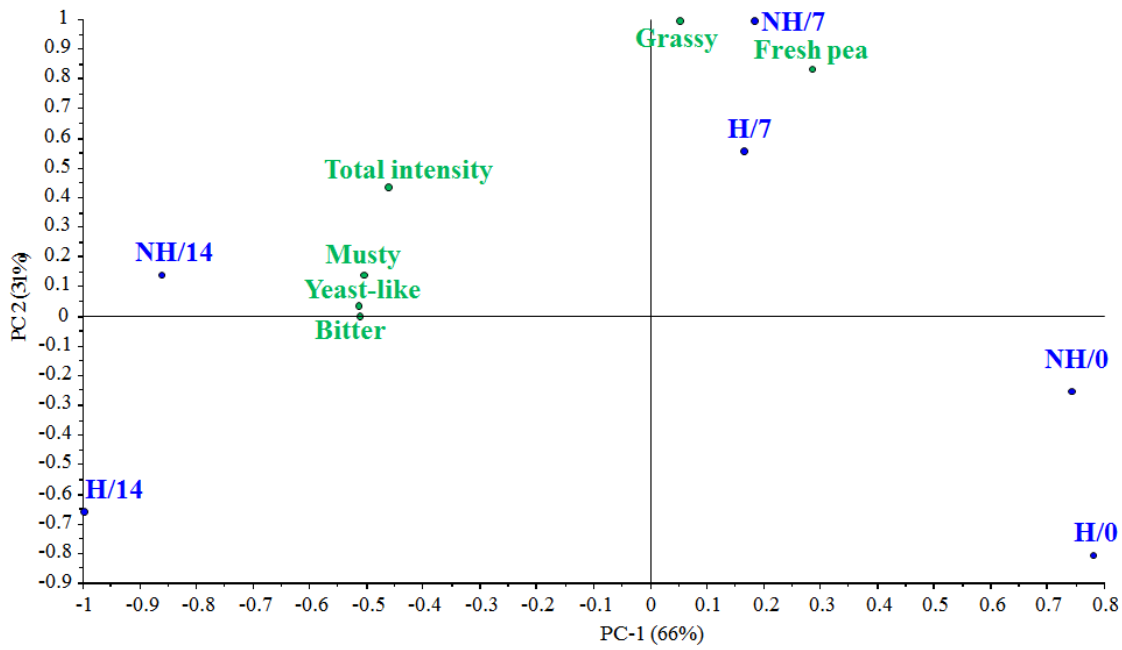



*Figure 4*. PCA plot for the perceived intensity of aromas. NH = No heat treatment; H = Heat treatment; 0, 7, 14 days of storage.

### Analysis of volatile compounds

The volatile compounds found in the samples are presented in the PCA biplot (Figure 5). There, the aroma compounds of the samples (surface areas of the chromatographic peaks) and the averages of the detected intensity of the aromas are combined. The volatile compounds of greater quantity are listed in Table 3. In Figure 5, it was observed that the aroma of bitterness and yeast-like correlated with 3-methyl-1-butanol. The concentration of this compound in H and NH samples, and stored for up to 14 days, was relatively low compared to other compounds (Table 3). Moreover, H samples stored for 7 and 14 days reached the highest levels of 3-methyl-1-butanol.

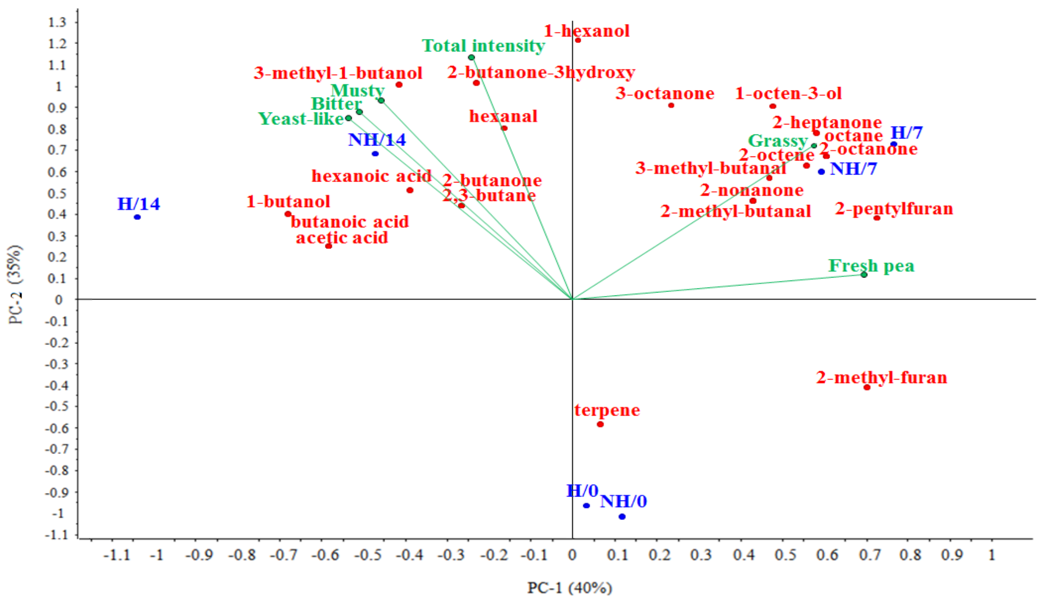



*Figure 5*. PCA plot where volatile compounds (identified through gas chromatography) and the perceived intensity of aromas are combined. NH = No heat treatment; H = Heat treatment; 0, 7, 14 days of storage.

Table 3

*Major volatile compounds in the suspensions of faba beans*

| NH/0 | NH/7 | NH/14 | H/0 | H/7 | H/14 |
|---|---|---|---|---|---|
| 2-methylfuran<br>(4 115 040) | 1-hexanol<br>(19 946 670) | 2-butanone-3-hydroxy<br>(41 782 412) | 2-methylfuran<br>(3 707 030) | 3-methyl-1-butanol<br>(22 769 940) | 3-methyl-1-butanol<br>(25 393 018) |
| | 2-butanone-3-hydroxy<br>(18 463 582) | 3-methyl-1-butanol<br>(40 219 860) | | 1-hexanol<br>(17 747 355) | Acetic acid<br>(22 446 826) |
| | 3-methyl-1-butanol<br>(15 313 897) | 1-hexanol<br>(17 516 052) | | 2-butanone-3-hydroxy<br>(17 417 733) | 2-butanone-3-hydroxy<br>(12 899 695) |
| | 2-methylfuran<br>(4 223 931) | 2-butanone<br>(5 571 265) | | 3-methylbutanal<br>(10 864 550) | 1-hexanol<br>(10 701 280) |
| | | | | 2-methylfuran<br>(4 747 816) | |

*Note*: The numbers in parentheses represent the average of the areas under the chromatographic peaks. NH= No heat treatment; H = Heat treatment; 0, 7, 14 days of storage.

Content of 3-methyl-1-butanol seems to correlate with the overall flavor intensity. Based on Figure 5, the overall flavor intensity can be related to the concentration of compounds such 2-butanone-3-hydroxide, hexanal and hexanol-1. The concentration of 2-butanone-3-hydroxide was higher in the NH samples, stored for 14 days; 2-butanone-3-hydroxido also had a high correlation with the total intensity of aromas. The second largest concentration of 2-butanone-3-hydroxide corresponds to NH samples, stored for 7 days, and the third largest concentration of this compound corresponds to H samples, stored for 7 days (slightly higher than H samples stored for 14 days). The concentration of 1-hexanol was the greatest in NH samples, stored for 7 days; these samples are characterized by a strong aroma of fresh peas. In H samples, the concentration of 1-hexanol was low compared to NH samples. Given the intensity of grassiness and the high concentrations of 1-hexanol, it is reasonable to think that this compound is somehow related to perceived grassiness.

Based on Figure 5, the intensity of grassy aroma correlated with various compounds such as 2-heptanone, octane, 2-octanone, 3-methyl butanal, 2-nonanol, and 2-methyl butanal, but only the concentration of 3-methylbutanal has been observed in H samples, stored for 7 days. The aroma of fresh pea was strongly associated with 2-pentylfuran, but this compound was found in low concentrations in every sample. Interestingly, the results of sensory evaluation showed that the aroma of fresh peas was one of the most intense. This suggests that there is no direct correlation between the aroma of fresh peas and the 2-pentylfuran, or that the compound causes a strong aroma even at low concentrations.

Fresh samples presented aromas of low intensity and, generally, very low concentration of volatile compounds. 2-methylfuran had the highest concentration in fresh samples, but was also detected in samples stored for 7 days.

At 14-day storage, 2-butanone and 2,3-butane were detected in NH samples while acetic and butyric acid were detected in H samples.

## DISCUSSION

The panellists were able to differentiate between the following aromatic descriptors: Fresh peas, yeast-like, musty, bitter and grassy. More reliable results would have been obtained with a greater number of panellists and longer training. Despite this, panellists' performance was acceptable. The effect of the interaction between replication and storage time on musty aroma was significant ($p$ = .03), which may indicate some discrepancy among panellists (Kälviäinen, Roininen, & Appelbye, 2005). Panellists may not have understood attributes same way, or the samples were not sufficiently distinguishable. It is believed that the interaction with replicate and the large standard deviations may have resulted from insufficient training.

As mentioned in the introduction, the characteristic aroma of the beans and the generation of volatile compounds have been a topic of some study (Vara-Ubol et al., 2004; Bott & Chambers, 2006). The head-space analyses of H and NH samples, stored for up to 14 days, allowed the identification of various oxidation products such as hexanal, 1-hexanol, 2-heptanone, 2-pentylfuran, 1-octen- 3-ol, and hexanoic acid. From these, the concentration of 1-hexanol was high in most samples. In addition to 1-hexanol, the concentration of

2-butanone-3-hydroxy and 3-3-methyl-1-butanol was considerable. In literature, at least 3-methyl-1-butanol has been found to cause, in conjunction with hexanal, aromas identified as "peas", "bad boil ", horseradish '. These compounds together with 1-octen-3-ol seemed to cause flavors identified as 'beans', 'peas', 'bitter' and 'dill' (Bott & Chambers, 2006). The correlation between the perceived intensities of various aromas and volatile compounds suggests the positive effect of some compounds of low concentration on the formation of aromas. Therefore, the combined impact of volatiles could determine the occurrence of a particular aroma detected by the panel.

The total aroma intensity appeared to be largely affected by the concentration of compounds such as 3-methyl-1-butanol, 2-butanone and 3-hydroxy 1-hexanol. The possible interactions between volatiles make it hard to suggest a direct relationship between concentration and intensity. For example, Bott and Chambers (2006) noted that the most intense aroma of pea formed from a combination of hexanal and 1-octen-3-ol. The same combination may have occurred in this study, even if the concentrations of these compounds were low. In order to obtain reliable results, these compounds should be studied in aqueous suspensions of beans, and then identified their role in the formation of specific aromas.

According to the study conducted by Wang, Dou, Macura, Durance and Nakai (1998), alcohols, aldehydes, hexanol and hexanal are the main compounds associated with the aroma of green bean in many soy products. Wang et al. (1998) also found that hexanol, hexanal and the lipoxygenase enzyme present a positive linear correlation. In the present study, several volatile compounds such as 1-hexanol, and the total aroma intensity were mostly detected in NH samples. This suggests that the heat treatment may have an inhibitory effect on the enzymatic activity and thus, suppressed volatile production. Due to the presence of amino acids, volatile compounds with amide groups could be released during heat treatment, leading to the formation of aromas during storage (Rodríguez-Bernaldo De Quirós et al., 2000). The storage time intensified the formation of aromas in suspension, indicating possible enzyme activity and/or oxidation of lipids. Also, it is noteworthy that the suspensions were prepared with distilled water, so all bacteria and yeast present in faba beans could have caused lipid oxidation and fermentation, particularly in samples without heat treatment. Thus, it is reasonable to think that the aromas perceived from suspensions stored for 14 days, such as yeast-like or bitter, may well be off-odours induced by spoilage.

## CONCLUSIONS

This preliminary study showed that aroma of faba bean suspensions was mostly affected by storage time, while heat treatment had a lesser effect. An interaction effect between replicate and storage time showed that panellists may not have been thoroughly trained for aroma detection, or samples were indistinctively similar. Despite this, replicate had (per se) no distinct effect on the results. Regardless of the heat treatment, suspensions stored for 7 days were strongly associated with the aroma of fresh pea and grassy while those stored for 14days were associated with the aroma of musty, bitter and yeast-like. In terms of volatile compounds, major differences were not observed up to 7 days. However, heat treated suspensions stored for up to 14 days had a considerably higher content of e.g. acetic acid, and much lower content of e.g. 3-methyl-1-butanol compared to the non-heat treated suspensions. Enzymatic activity in non-heat treated suspensions might have led to production of distinct volatile compounds with, apparently, the same effect on the aroma profile as heat treated suspensions.

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## APPENDIX

Appendix 1. List of descriptors suggested by the panel leader during the first training. The training was originally conducted in Finnish language*.

| Descriptors [ENG] | Descriptores [SPA] | Kuvaajat [FIN*] |
|---|---|---|
| Almond sour | Almendra amarga | Mantelimainen hapan |
| Beany | (similar a) frijol | Papumainen |
| Bitter | Amargo | Kitkerä |
| Brown | Marrón | Ruskea |
| Dusty | Polvoso | Pölyinen |
| Fat | Graso | Rasvainen |
| Fungous | Fungoso | Sienimäinen |
| Grassy | (similar a) césped | Ruohomainen |
| Green | Verde | Vihreä |
| Moldy | Mohoso | Homeinen |
| Musty | Rancio | Ummehtunut |
| Nutty | (similar a) nuez | Pähkinäinen |
| Oily | Aceitoso | Öljymäinen |
| Pod | Guisantes | Herneenpalko |
| Soil-like | (similar a) suelo | Maamainen |
| Stale | Pan rancio | Tunkkainen |
| Starch | Almidón | Tärkkelys |

**Appendix 2.** Total set of descriptors proposed by the panel during the first training. The training was originally conducted in Finnish language.

| Descriptors [ENG] | Descriptores [SPA] | Kuvaajat [FIN] |
|---|---|---|
| Bitter | Amargo | Kitkerä |
| Cheese-like | (similar a) queso | Juustoinen |
| Fresh | Fresco | Raikas |
| Fresh pea | Guisantes frescos | Tuore hernemäinen |
| Grassy | (similar a) césped | Ruohomainen |
| Green | Verde | Vihreä |
| Liquorice-like | (similar a) Regaliz | Lakritsimainen |
| Mushroom-like | (similar a) Hongos comestibles | Herkkusienimäinen |
| Musty | Rancio | Ummehtunut |

| | | |
|---|---|---|
| Nutty | (similar a) nuez | Pähkinäinen |
| Oily | Aceitoso | Öljymäinen |
| Peel-like | (similar a) cáscaras de fruta | Kuoren aromi |
| Petrol-like | (similar a) gasolina | Bensa |
| Sesame | Ajonjolí | Seesami |
| Soil-like | (similar a) suelo | Maamainen |
| Sour | Agrio | Hapan |
| Sprout-like | (similar a) Brote de una planta | Itumainen |
| Stale | Pan rancio | Tunkkainen |
| Toasty | Tostado | Paahteinen |
| Waxy | (similar a) cera | Vahamainen |
| | | |