Sensory Evaluation of Minimally Processed Parsley (*Petroselinum crispum*), Dill (*Anethum graveolens*) and Lovage (*Levisticum officinale*) Stored at Refrigeration Temperatures

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Abstract. Minimally processed fresh fruit, vegetables and aromatic herbs are a becoming more popular because they satisfy consumers’ need for time and healthy nutrients. But, even applying packaging and refrigeration their shelf life is short. The main quality losses that occur along storage are changes in colour, texture and flavour. In consequence, it is important to establish how these factors affect acceptance and preference of minimally processed fresh plant food. So, the aim of the present paper is to evaluate the effect of storage at refrigeration temperature on some quality characteristics of the most important minimally processed Romanian seasoning herbs. The herbs under study were parsley, dill and lovage. A grid of attributes of fresh herbs was developed. The herbs, sealed in polyethylene bags, were stored at 4°C for 12 days. The evaluation of quality characteristics color, texture and flavor, on a scale of 1 to 5 was done in the 1st, 5th, 8th and 12th day. In order to evaluate the average quality of the herbs, a quality number was used. Starting form herbs scores in the first day, a sensory profile was determined. This was maintained along the storage period. Even though, scores decreased along the storage period, there were no statistically significant differences for any of the parameters under study in the days taken into consideration. Quality number along the storage period do not differ statistically for none of the three herbs. For minimal processed parsley, dill and lovage the maximum shelf-life was estimated to be 23.3 days, 13.7 days and 15.3 days respectively.

Keywords: parsley, dill, lovage, minimally processed, sensory analysis, refrigeration

INTRODUCTION

Minimally processed fresh fruit, vegetables and aromatic herbs are a becoming more popular because consumers dedicate less time to the preparing of their meals. They are a rich source of nutrients and they have become a growing market worldwide because of the new lifestyle (Landgraf, 2006). They are foods that have fresh like characteristics and also provide the convenience demanded by consumers. This products are also called “fresh-cut” or “ready-to-eat”. Minimally processed fresh plant food needs minimal or no further processing prior to consumption. The term “minimally processed” fresh plant food refers to plant items that have gone through mild treatments: washing, cutting, grating, shredding, pulling the leaves off, etc. (Artés and Allende, 2005). They have no additives added and traditional preservation methods such as freezing, dehydration or salting are never employed. The usual methods employed usually in order to extend their shelf-life are washing with chlorinated water, modified atmosphere packaging and refrigeration (Wiley, 1994). However, even applying refrigeration and modified atmosphere packaging, these products have a short shelf life, usually 5-7 days at refrigeration temperature (Hammad, 2006; Trigo M. et al. 2006).

Because cold storage is the only means of prolonging their shelf life, this products are prone to deterioration by physiological ageing, biochemical changes and microbial
spoilage stages (Artés and Allende, 2005). The main quality losses that occur along storage are changes in colour (discoloration, yellowing), texture (loss of crispness or juiciness), flavour (off-flavours) and water losses. All this parameters are sensory properties, being of the most important factors on consumer liking and preference (Dos, 2005; de Melo, 2009). In consequence, it is important to establish how these factors affect acceptance and preference of minimally processed fresh plant food. This gives sensory evaluation of products a crucial importance. Sensory analysis, in food science, is used to measure, analyze and interpret characteristics of food as they are perceived by sight, smell, taste, touch and hearing (Haselau, 2009; Ghasemi-Varnamkhasti, 2012; Straumite, 2012).

According to EUROSTAT and FAOSTAT, Romania is the third herb and spice consumer in UE, so minimally processed herbs were analysed for the present study. Some of the aromatic herbs most consumed Romania are parsley, dill and lovage, which can be stored at 18-20°C and 85–90% humidity for about 3 days (Azeez, 2008). Romanian quality standard STAS-12550-87 referring to leafy vegetables for fresh consumption states the minimal requirements: leaves must be whole, healthy, devoid of diseases, rots and pests, their color must be characteristic to the variety, with a fresh appearance (without yellow parts), clean, with no abnormal external humidity, foreign taste and smell and floral stem. These requirements all refer to sensory characteristics, reinforcing the importance of sensory analysis of products prior to large scale distribution.

Minimal processed plant products are little studied in Romania, so we wanted to asses, from a consumer’s point of view, the evolution of parsley, dill and lovage, as minimal processed herbs, along their shelf-life. In order to do this we stored parsley, dill and lovage samples packed in polyethylene bags at 4°C for up to 12 days and tested the samples during storage for sensory characteristics.

MATERIALS AND METHODS

1. Raw material and preparation of samples

Fresh biologic material, parsley (Petroselinum crispum), dill (Anethum graveolens) and lovage (Levisticum officinale) was purchased from a local supermarket (at the same day of receiving) in Cluj-Napoca. Samples were prepared as follows: batches were homogenized and then examined visually. Foreign bodies and plant materials were removed, together with yellow and withered leaves. The stems were cut to approximately 6 cm. The leaves were cleaned, washed with tap water, air dried. The batches of each plant was divided into 6 groups of 50g. Each sample of 50 g was termosealed in a 15x20 cm polyethylene bag (Krups Vacupack Plus F380). The samples were stored at 4°C up to 12 days. Samples from the 1st, 5th, 8th and 12th day of storage were taken for analyses.

2. Sensory analysis

The sensory analysis is based on an analytical, descriptive test, which provides a description of the sensory qualities of food and their change over time (ISO 13299:2003; Meilgaard, 1999). The characteristics that were taken into account, starting from STAS-12550-87 and Trigo (2009), were color, texture and flavor. Texture and flavor were assessed using two parameters: firmness and succulence, and taste and odor, respectively. A list of attributes of fresh herbs was developed with Straumite (2012) grid for fresh dill as a model. Each characteristic was scored on a scale of 1 to 5, 5 being the largest score (Basbayraktar, 2006). The grid together with the score for each attribute is presented in tab. 1.

A panel of 15-25 assessors was chosen from students taking a Sensory Analysis course. The panelists were trained on the product attributes.
Samples, placed on white plates, coded with three-digit random numbers and were served at uniform, room temperature. They were presented monadically (in succession, one-by-one) because of the strong, persistent flavours. The sensory evaluations were conducted at room temperature under normal laboratory light conditions.

List of sensory attributes of fresh herbs with descriptions and scores

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>dark, typical green</td>
<td>characteristic color of fresh herbs</td>
<td>5</td>
</tr>
<tr>
<td>firm and crispy</td>
<td>stem and leaves are firm and crispy, characteristic of fresh herbs</td>
<td>5</td>
</tr>
<tr>
<td>light, non typical green</td>
<td>herbs have lost some of their color, but can be considered relative fresh</td>
<td>4</td>
</tr>
<tr>
<td>firm, but less crispy</td>
<td>herbs have lost some of their crispiness, but are still firm and can be considered relative fresh</td>
<td>4</td>
</tr>
<tr>
<td>yellowish-green with gray or brown spots</td>
<td>herbs are light green, untypical for fresh leaves</td>
<td>3</td>
</tr>
<tr>
<td>light, non typical green</td>
<td>herbs are slightly wilted, first signs of spoilage</td>
<td>3</td>
</tr>
<tr>
<td>yellowish-green with gray or brown spots</td>
<td>herbs are stored too long and spoilage has started</td>
<td>2</td>
</tr>
<tr>
<td>firm and crispy</td>
<td>stem and leaves are firm and crispy, characteristic of fresh herbs</td>
<td>5</td>
</tr>
<tr>
<td>firm, but less crispy</td>
<td>herbs have lost some of their crispiness, but are still firm and can be considered relative fresh</td>
<td>4</td>
</tr>
<tr>
<td>greenish–yellow</td>
<td>slightly wilted and herbs have lost freshness</td>
<td>3</td>
</tr>
<tr>
<td>less firm with no crispiness</td>
<td>wilted, first signs of spoilage</td>
<td>2</td>
</tr>
<tr>
<td>rather soft</td>
<td>herbs are softened, spoilage has started</td>
<td>1</td>
</tr>
<tr>
<td>very soft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fresh and juicy</td>
<td>stem and leaves are fresh and juicy, characteristic of fresh herbs</td>
<td>5</td>
</tr>
<tr>
<td>fresh, but less juicy</td>
<td>herbs have lost some of their succulence, but can still be considered relative fresh</td>
<td>4</td>
</tr>
<tr>
<td>rather sere</td>
<td>herbs have lost almost all their succulence and appearance of freshness</td>
<td>3</td>
</tr>
<tr>
<td>dry</td>
<td>herbs have lost all their succulence and are beginning to dry</td>
<td>2</td>
</tr>
<tr>
<td>dry</td>
<td>herbs were stored too long and are dried</td>
<td>1</td>
</tr>
<tr>
<td>strong, typical herb taste</td>
<td>fresh herb taste</td>
<td>5</td>
</tr>
<tr>
<td>strong herb taste</td>
<td>herbs have lost some of their taste, but can be considered relative strong</td>
<td>4</td>
</tr>
<tr>
<td>moderate herb taste</td>
<td>herbs have lost almost all their typical taste</td>
<td>3</td>
</tr>
<tr>
<td>green grass taste</td>
<td>green grass taste combined with a slight herbs aroma</td>
<td>2</td>
</tr>
<tr>
<td>non-typical, unsightly</td>
<td>green grass, hey or spoilage taste</td>
<td>1</td>
</tr>
<tr>
<td>taste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>strong, typical herb odor</td>
<td>characteristic odor of fresh herbs</td>
<td>5</td>
</tr>
<tr>
<td>strong herb odor</td>
<td>pleasant herb odor</td>
<td>4</td>
</tr>
<tr>
<td>moderate herb odor</td>
<td>herbs have lost almost all their typical odor</td>
<td>3</td>
</tr>
<tr>
<td>green grass odor</td>
<td>green grass odor, herb odor is not noticeable</td>
<td>2</td>
</tr>
<tr>
<td>non-typical, unsightly</td>
<td>hey or spoilage odor</td>
<td>1</td>
</tr>
<tr>
<td>odor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to evaluate the average quality of the herbs, a quality number (QN) was used (Nießen, 2007 quoted by Straumite 2012). QN was calculated according to equation 1:

\[
QN = \frac{Co + Ap + Ar}{3} \quad (1)
\]

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where:

\[ Co – \text{fresh herb color} \]
\[ Ap – \text{fresh herb appearance} \]
\[ Ap = \frac{Fi + Su}{2} \]

where:

\[ Fi – \text{fresh herb firmness} \]
\[ Su – \text{fresh herb succulence} \]

\[ Ar = \frac{Od + Ta}{2} \]

where:

\[ Od – \text{fresh herb odor} \]
\[ Ta – \text{fresh herb taste} \]

Based on QN the average quality of the fresh herbs was classified as follows:

- 5.00–4.50 – very good quality (ideal quality parameters)
- 4.49–3.50 – good quality (minor quality deviations)
- 3.49–2.50 – average quality (pronounced deviations, insignificant defects)
- 2.49–1.00 – unsatisfactory quality (serious defects)

RESULTS AND DISCUSSIONS

Sensory analysis was performed four times in a 12-day time span. As presented in tab. 1 and confirmed by Straumite (2012), fresh herbs should be of a rich green or green color, succulent, and with typical odor and taste (spicy, herbaceous, fresh). The stems should be firm and crispy.

The results of the sensory analysis, presented in fig. 1, show in the first day of storage, dill was evaluated with the highest score for color, 89% out of the maximum of 5, statistically different from parsley, 71%, and lovage, 76%, who had similar scores.

There were no differences among firmness scores. Dill was scored higher for succulence than parsley (84% to 70%). Lovage score highest for odor and taste, but it was statistically different only from parsley. Hammad et al. (2006) who studied sensory evolution of fresh-cut lettuce, also acquired scores smaller than maximum in the first day of storage. So, they determined that texture, associated with firmness, was 95.6 %, wilting (succulence) 88.9 % and odor 95.6 % out of 9. Based on the scale of QN, lovage had a very good, specific strong odor. Parsley had firmness, taste and odor of average quality, with some deviations.

In the 5th day of storage, color decreased by 1.6% for parsley samples and by 4.6% for dill samples, a slight decrease compared to 11% for fresh-cut lettuce stored in the same conditions (Hammad 2006). There was no change in color for lovage. Succulence was affected by storage and reduced with 3.6% for lovage samples and 4.6% for dill, compared with 11% in the case of fresh-cut lettuce (Hammad 2006). Parsley was not affected in what juiciness was concerned. Odor decreased for lovage samples with 4.%, similar to 4.4% for fresh-cut lettuce (Hammad 2006). Although some modification appeared for each herb, none was statistically significant from a sensory analysis point of view.

At the end of the trial, after 12 days of storage at 4°C, dill samples had the most important decrease in color score, 12.7%, while parsley and lovage had a decrease of only 2.7%. Hammad et al. (2006) observed that color of fresh-cut lettuce arrived at 33% after just 10 days. While Fan et al. (2006), after 14 days storage at 4°C, found that parsley arrived at 69% of total scores for visual quality, cilantro at 61%, green-leaf lettuce at 60% and celery at only 43%. Firmness scores diminished slightly for all samples. Succulence scores arrived at 67% in the case of parsley, a very high score, compared with 21 % found by Fan et al. (2006). Dill scored with 11.7% less for succulence. The changes in odor and taste scores were most significant for lovage, because they diminished with 15.7 % and 10.7%, respectively.
Even though, scores decreased along the storage period, there were no statistically significant differences for any of the parameters under study in the days taken into consideration. A similar situation was encountered by Landgraf et al. (2006) who studied watercress during shelf-life at a refrigeration temperature of 7°C.

Note: Different letters for each storage day represent significant differences (Fisher (LSD), p < 0.5) among scores.

Fig. 1. Minimally processed parsley, dill and lovage scores means for each characteristic along storage period

Note: Different letters represent significant differences (Fisher (LSD), p < 0.5) among scores.

Fig. 2. Minimally processed parsley, dill and lovage quality numbers along storage
QN along the storage period do not differ statistically for none of the three herbs (fig. 2). Dill and lovage could be considered as good quality with minor quality deviations for the 12 days of study, while parsley was of average quality sometimes with pronounced deviations, but with insignificantly defects. Landgraf et al. (2006) found a similar situation in the case of watercress stored at 7°C. In the first day, the acceptance score was of 76.7% out of the maximum score compared to 68.50% for parsley, 82.17% for dill and 80.17% for lovage. After 12 days, they observed a 15.6% decrease in the acceptance score compared with 1.67% for parsley, 8.50% for dill and 6.67% for lovage.

Shelf-life curves of minimally processed parsley, dill and lovage (fig. 3) show the decrease of quality numbers over time. The present study did not arrive at the end of the herbs shelf life, but their storage period can be estimated using the shelf-life curves. So, for minimal processed parsley, dill and lovage the maximum shelf-life is 23.3 days \((R^2 = 0.4765)\), 13.7 days \((R^2 = 0.9815)\) and 15.3 days \((R^2 = 0.9539)\), respectively.

![Shelf-life curves](image)

Fig. 3. Shelf-life curves of minimally processed parsley, dill and lovage showing the decrease of quality numbers over time

**CONCLUSION**

Minimally processed parsley, dill and lovage were assessed from a consumer’s point of view along their shelf-life. In order to do this parsley, dill and lovage samples were stored packed in polyethylene bags at 4°C for up to 12 days and tested the samples during storage for sensory characteristics. The characteristics that were taken into account were color, texture and flavor. Texture and flavor were assessed using two parameters: firmness and succulence, and taste and odor, respectively. A grid of attributes of fresh herbs was developed. Each characteristic was scored on a scale of 1 to 5, 5 being the largest score. In order to evaluate the average quality of the minimally processed herbs, a quality number (QN) was used.

Starting from herbs scores in the first day, a sensory profile was determined. Lovage is characterized by a strong taste and odor, so by a very particular aroma, dill is a dark green colored herb, with fresh and juicy stem and leaves, while parsley has a green to light green color, with a more subtle flavor.

In the 5th and 8th day of storage, although some modification appeared for each herb, none was statistically significant from a sensory analysis point of view. At the end of the trial, after 12 days of storage at 4°C, dill samples had the most important decrease in color and succulence, while the changes in odor and taste scores were most significant for lovage. Even
though, scores decreased along the storage period, there were no statistically significant differences for any of the parameters under study in the days taken into consideration.

The sensory profile established in the first day of storage was maintained along the storage period, dill kept high scores for color and succulence, while lovage for taste and odor. Parsley, on the other hand, although did not scored that high in the first day of storage, at the end of the trial period, its sensory attributes were less affected by storage.

QN along the storage period do not differ statistically for none of the three herbs.

Although, the present study did not arrive at the end of the herbs shelf life, but their storage period can be estimated using the shelf-life curves. So, for minimal processed parsley, dill and lovage the maximum shelf-life is 23.3 days ($R^2 = 0.4765$), 13.7 days ($R^2 = 0.9815$) and 15.3 days ($R^2 = 0.9539$), respectively.

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