

Quality Characteristics of Fresh Cut Oregano (*Origanum Vulgare* L.) Depending on Packaging Material During Cold Storage

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Abstract: Consumers consider that polymers as a material for food packaging are overly used, and they support the idea of introducing new eco-friendly food packaging. The research aimed to investigate the effect of two biodegradable packaging materials – Nature Works® PLA P-360 boxes with hermetically pressed PLA cover and NatureFlex™ NVS INNOVIA film – and one “breathable” conventional BOPP Propafilm™ P2GAF film influence on quality characteristics of fresh cut oregano during cold storage. Oregano samples (20±0.05 g) had packed from the *ex situ* collection of genetic resources of aromatic and medicinal plants (N 56°39'47"; E 23°45'13") of the Latvia University of Life Sciences and Technologies and cold stored at temperature +6.0±0.5 °C up to 15 days. During investigations, the gas composition in the free space of the package (O₂ and CO₂), changes of weight, pH and soluble solids (°Brix) as well as sensory analysis were obtained. Analysis of the oregano samples had tested out before (1st day) and after packaging on 3rd, 5th, 8th, 10th, 12th and 15th days` of storage, in triplicate. The results suggest that biodegradable packaging materials can be used as alternative to the conventional polymers for packaging of fresh oregano, which could provide an essential contribution in reducing the environmental pollution.

Keywords: fresh herbs, sensory analysis, weight loss, gas composition.

1. Introduction

Herbs refer to herbaceous plants that means leafy green parts of culinary and aromatic plants. The trade value of herbs is increasing throughout Europe – they are available as freshly cut, packaged, frozen, potted, dried etc. That is why herbs can be defined as important element for economic development [1]. According to Artés and Allende (2005), fresh plants using as food needs minimal or no further processing prior to consumption [2]. It means, the minimally processed herbs have gone through mild treatments: washing, cutting, grating, shredding, pulling the leaves off etc. As well as no additives added and traditional preservation methods as freezing, dehydration or salting are never employed. The main quality losses of fresh cut herbs during storage are changes in weight (water losses), colour (discoloration, yellowing), texture (loss of crispness or juiciness) and flavour [3].

Packaging as integral and determinant part of the industrial and commercial food industry protects products from damage, against secondary contamination, allows efficient transportation and distribution, offers convenience, prolongs shelf life, provides easy use, informs consumers and promotes goods in a competitive market place [4]. Consumers consider that polymers as a material for food packaging are overly used, and they support the idea of introducing new eco-friendly and food packaging. As well as consumer-defined eco-friendly food packaging should be visually appealing while satisfying consumers` environmental expectations relating to packaging materials and manufacturing process [5].

Oregano (*Origanum vulgare* L.) is multifunctional aromatic and medicinal plant, widely used as fresh herb for enrichment the taste and aroma of dishes as well as for decoration, as raw material for cosmetic production and fragrance industry, for pharmaceutical needs [6, 7]. Minimal processed packaged oregano is not widely studied in the world – few data about shelf-life, weight losses and sensory characteristics of fresh cut samples are available. Any additional research, especially in the frame of the use of innovative packaging material for fresh oregano storage, will be important for growers, consumers and marketing specialists.

Experiment aimed to analyze the quality characteristics of fresh cut oregano depending on different packaging material under cold storage.

2. Materials & Methods

2.1. Plant material and preparation of samples

Fresh oregano plants were harvested before bud stage from the *ex situ* collection of genetic resources of aromatic and medicinal plants (N 56°39'47''; E 23°45'13''), at the Latvia University of Life Sciences and Technologies. Fresh, clean (with drinking water washed), whole, non-damaged plant material was packaged by 20±0.05 g in biodegradable and conventional packaging materials. Samples within 15 days were stored in a commercial Freezer/Cooler “Elcold” at the temperature of +6.0±0.5 °C.

2.2. Packaging materials

During experiment fresh cut oregano before storage was placed into:

- biodegradable packaging material Nature Works® PLA P-360 boxes with hermetically pressed PLA cover (size 10×9×5 cm);
- DuniForm polypropylene (PP) boxes, melted with biodegradable NatureFlex™ NVS INNOVIA film;
- DuniForm polypropylene (PP) boxes, melted with “breathable” conventional BOPP Propafilm™ P2GAF film.

DuniForm PP boxes (size 20.5×14.5×3.5 cm) were placed in pre-prepared (size 25 x 24 cm) pouches made of biologically degradable NatureFlex™ NVS INNOVIA material and hermetically melted using the packaging equipment (EUROMATIC, Italia). The same DuniForm PP boxes were hermetically melted with “breathable” conventional polymer BOPP Propafilm™ P2GAF film covered with an anti-dew coating by means of SEAL 300 Faverani (Italia) equipment. The quality of oregano was assessed before packaging and during storage (on the 3rd, 5th, 8th, 10th, 12th and 15th day), in three repetitions.

2.3. Measurements

Weight loss was detected according to the standard method LVS ISO 1442:1997 as the percentage loss of the initial total weight. For measurements, digital balance Precisa (Germany) with a weighing accuracy of ±0.01 g was used.

pH value was measured using Jenway 3510 pH meter, by the standard method LVSISO 5542:2010.

The total soluble solids content (expressed as °Brix) was measured with a refractometer (A.KRÜSS Optronic Digital Handheld Refractometer Dr301-95) calibrated at 20°C with distilled water.

CO₂ and O₂ concentration (%) in head space of packaging was detected by the company's Witt standard method with the gas analyzer "OXYBABY" ECO directly after packaging and during storage.

All above mentioned measurements were explored for each packaging material on the 1st, 3rd, 5th, 8th, 10th, 12th and 15th days during storage, in triplicate.

2.4. Sensory analysis

The sensory evaluation was conducted at room temperature, under natural light conditions, according to methodology developed by Dr. sc. ing. Evita Straumīte [8] as well as by Romanian scientists [3], Table 1.

TABLE I: The Methodology of Sensory Evaluation of Fresh Oregano Samples

Parameter	Characteristics	Description	Score
Color	Dark, typical green	Characteristic color of fresh herbs	5
	Green	Herbs have lost some of their color, but can be considered as relative fresh	4
	Light, non-typical green	Herbs are light green, untypical for fresh leaves	3
	Greenish – yellow	Herbs are slightly wilted, first signs of spoilage	2
	Yellowish-green with gray or brown spots	Herbs are slightly wilted, first signs of spoilage	1
Firmness	Firm and crispy	Stem and leaves are firm and crispy, characteristic of fresh herbs	5
	Firm, but less crispy	Herbs have lost some of their crispiness, but are still firm and can be considered relative fresh	4
	Less firm with no crispiness	Slightly wilted and herbs have lost freshness	3
	Rather soft	Wilted, first signs of spoilage	2
	Very soft	Herbs are softened, spoilage has started	1
Succulence	Fresh and juicy	Stem and leaves are fresh and juicy, characteristic of fresh herbs	5
	Fresh, but less juicy	Herbs have lost some of their succulence, but can still be considered as relative fresh	4
	Rather sere	Herbs have lost almost all their succulence and appearance of freshness	3
	Sere	Herbs have lost all their succulence and are beginning to dry	2
	Dry	Herbs were stored too long are dried	1
Taste	Strong, typical herb taste	Fresh herb taste	5
	Strong herb taste	Herbs have lost some of their taste, but can be considered relative strong	4
	Moderate herb taste	Herbs have lost almost all their typical taste	3
	Green grass taste	Green grass taste combined with a slight herb aroma	2
	Non-typical, unsightly taste	Green grass, hey or spoilage taste	1
Odor	Strong, typical herb odor	Characteristic odor of fresh herbs	5
	Strong herb odor	Pleasant herb odor	4
	Moderate herb odor	Herbs have lost almost all their typical odor	3
	Green grass odor	Green grass odor, herb odor is not noticeable	2
	Non-typical, unsightly odor	Hey or spoilage odor	1

2.5. Statistical Analyses

The results were processed by mathematical and statistical methods. Two-way analyses of variance ($p \leq 0.05$) were used to determine significance of differences in atmosphere content (CO_2 and O_2) in head space of packs, changes between weight losses, total soluble solids content, pH value by different packed oregano samples.

3. Results and Discussion

The weight loss of fresh cut herbs during storage depends on the packaging permeability and the migration of evaporated water through the material into the surrounding environment. During our research, the weight losses of oregano under all types of packaging were significantly different ($p < 0.05$). The maximal weight loss after 15 days long storage achieved the result till 9.2% for Nature Works® PLA P-360 boxes, 0.75% – for NatureFlex™ NVS INNOVIA film and 1.6% – for BOPP

Propafilm™ P2GAF film. Researchers Sharma et al. (2018) suggest that weight loss of fresh herbs leaves could be due to transpiration and respiration. This might be due to the fact that an atmosphere of low oxygen and high carbon dioxide created by packaging reduced the respiration rate thus reducing weight loss and extended the storage life of produce through inhibition of physiological deterioration. Reduced rate of transpiration and respiration at low temperature might also be the reason of lower loss in weight at 5 °C [9]. Data about fresh and air-dry oregano, during drying process without using any packaging, concludes the weight losses around 40-60%, depending on the growing year [10].

During research, it was explored, that pH value had the tendency to increase, but it was non-significant ($p > 0.05$) difference between initial result 6.51 starting the experiment and 6.69 for Nature Works® PLA P-360 boxes, 6.70 – for NatureFlex™ NVS INNOVIA film and 6.66% – for BOPP Propafilm™ P2GAF film at the 15th day of experiment. Research of Mudalal et al. (2022) suggest that in vacuum packaging, in general, fresh oregano samples had no significant changes in pH during the storage period [11]. By Augšpole (2016), for carrots in the same packaging materials, pH value had the tendency to decrease during 12 days storage [12].

For total soluble solids content, it was the tendency to decrease significantly ($p < 0.05$) during the period of investigations – from 12.5 °Brix till 10.7 °Brix for Nature Works® PLA P-360 boxes, till 11.7 – for NatureFlex™ NVS INNOVIA film and till 12.2 °Brix – for BOPP Propafilm™ P2GAF firm at the 15th day of experiment. In comparison with other authors` data, the observed tendency for decreasing is similar [13], [14].

Dynamics of oxygen and carbon dioxide content changes inside packaging during oregano storage for 15 days are presented in Figure 1. The composition of the passive equilibrium shielding gas environment for packaging materials was changed differently during storage.

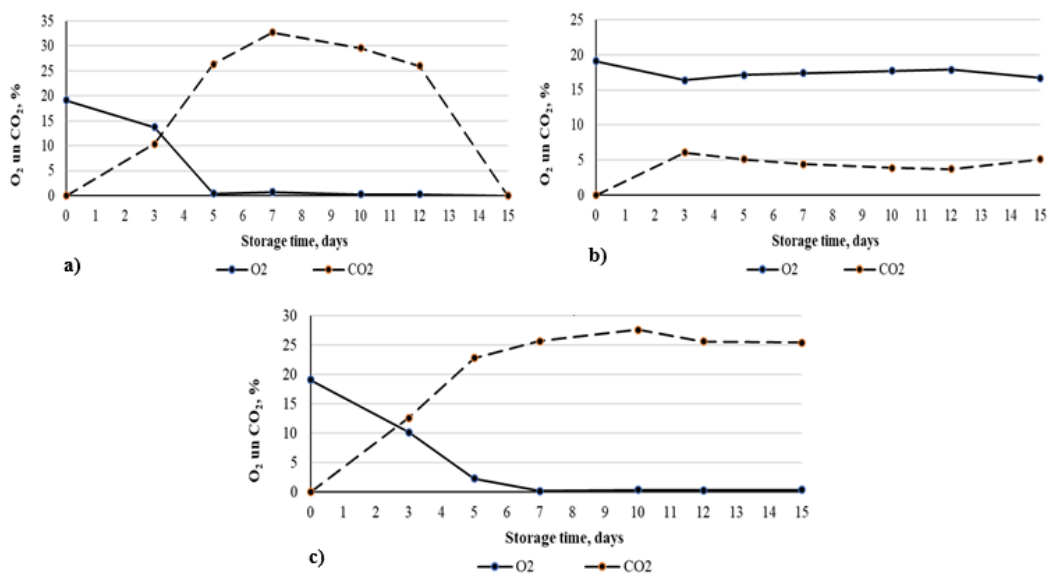


Fig. 1: Dynamics of oxygen and carbon dioxide content in oregano packaging during storage:
a) Nature Works® PLA P-360 boxes, b) NatureFlex™ NVS INNOVIA film,
c) BOPP Propafilm™ P2GAF film.

However, in based biodegradable NatureFlex™ NVS INNOVIA film`s packaging with oregano decrease of O₂ was not significant ($p > 0.05$) – at 10th day it was 3.9%. The increase of CO₂ in biodegradable NatureFlex™ NVS INNOVIA film`s packaging was not notable – not more than 3.7-6.1%, and that concentration remained constant during all 15 storage days (Figure 1. b). Namely, inside Nature Works® PLA P-360 boxes and BOPP Propafilm™ P2GAF film the content of O₂ in 3rd

day approached 13.7% and 10.2%, however starting from the 5th day of storage, the O₂ content significantly decreased. Differences in oxygen composition changes inside packaging during oregano storage mainly could be explained with various airtightness of packaging (Figure 1. a, c). Significant results were observed within oregano packaged in Nature Works® PLA P-360 and BOPP Propafilm™ P2GAF materials. Not significant differences were found in carbon dioxide content inside in Nature Works® PLA P-360 boxes and BOPP Propafilm™ P2GAF with oregano after 12 days (Figure 1. a, c). Biodegradable NatureFlex™ NVS INNOVIA packaging, which could be characterized as the best for fresh herbs produce respiration and quality maintenance in comparison with other packaging samples.

Starting from herbs scores in the first day, a sensory profile was determined (Figure 2).



Fig. 2: Changes in sensory quality of oregano under different packaging during storage, in scores.

On the 5th day of storage, for all types of packaging materials organoleptical losses were started. They were non-significant for NatureFlex™ NVS INNOVIA film and BOPP Propafilm™ P2GAF film, because samples received less scores only for odor, but more significant they were for oregano

from Nature Works® PLA P-360 boxes because of losses by odor, taste and succulence. On the 8th day of storage for both – Nature Works® PLA P-360 boxes and BOPP Propafilm™ P2GAF film – significant losses by all organoleptical parameters were observed. By observations, evaluation of these two packaging materials was terminated on the 8th day of the research. For research, provided by Romanian scientists in the case of dill, parsley and lovage, results of sensory evaluation were similar to data, received in our experiment [3]. After 8th day, only NatureFlex™ NVS INNOVIA film was not excluded – evaluation was continued till 15th day of storage, when odor was evaluated by minimal score. The prolonged shelf life of oregano samples in this packaging material can be described with optimal dynamics of oxygen and carbon dioxide content in packaging during storage. The obtained results indicate, that NatureFlex™ NVS INNOVIA film is suitable for storage of fresh cut oregano up to 12 days, preserving optimal sensory properties of plant material.

4. Conclusions

Biodegradable packaging materials can guaranty the same shelf life as provided by conventional polymer films. The results suggest that biodegradable packaging materials can be used as alternative to the conventional polymers for packaging of fresh oregano, which could provide an essential contribution in reducing the environmental pollution. Biodegradable NatureFlex™ NVS INNOVIA packaging could be characterized as the most appropriate for fresh oregano storage because of complex evaluation, including dynamics of oxygen and carbon dioxide content changes and sensory quality during storage.

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