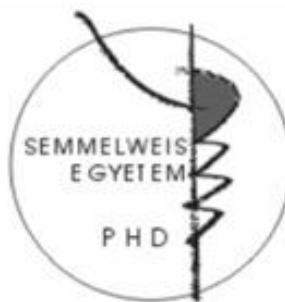


Investigation the role of fresh cut, packed vegetables in catering, and their storability

PhD Thesis

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Introduction

Increase the consumption of vegetables has got important role, as epidemiological studies demonstrated that their health promoting components can influence positively the incidence of chronic, non-infectious diseases.

Most of the Hungarian and international studies investigate the raw and processed vegetable consumption together, and WHO also gives a common recommendation: 400 g/day.

World Bank and the governments of many countries also recognized, that catering is a good field for publicize of healthy nutrition, and by that, the consumption of raw vegetables could be also stimulated.

Raw vegetables come to the canteen unprocessed, or minimal processed form (washed, cleaned, sliced, packed etc.). Grade of processing effects the processes of storage and preparing, including the places, machines, equipments, and manpower.

As catering manager do financial management, allocation of cost of acquisition of raw materials and costs of other activities equally important.

The traditional cost calculating model that is applied by the leaders of food factories do not allow the identification and analysis of the sources of costs.

Aims

Main aim of my study was to:

- Investigate the alterations of non-nutritive components (ascorbic acid content, chlorophyll content, antioxidant-capacity, soluble and bound peroxidase enzyme activity) changes of raw, and packed, minimally processed vegetables that can influence the quality of the product on different storage temperatures.
- Get to know the attitude of catering managers to use of raw and fresh cut, packed vegetables
- To do the analysis of cost of raw and fresh cut, packed vegetables in institutions that perform catering

Materials and methods

I hereby demonstrate the samples and methods of the three area of investigation separately

1. Storage trial

Laboratory measurements of my PhD work can be divided into two sections. In the first part I executed the investigation of single and multicomponent packed products. In the case of

multicomponent mixes, white cabbage or iceberg lettuce was among the components in each case. Based on the results of ascorbic acid measurements, lettuce (*Lactuca sativa* L.), white cabbage (*Brassica oleracea* convar. capitata var. alba) and corn salad (*Valerianella Locusta*) were chosen for the measurements of the second part of my laboratory work, where more detailed trial was performed with the determination of more parameters by the perform of storage trial.

During this trial, MAP (packed) samples of mine were iceberg lettuce, white cabbage and corn salad, which were compared to raw butterhead lettuce white cabbage and corn salad obtained from retail trade.

Alteration of non-nutritional substance value changes were analysed by the storage time and temperature.

All of the samples were measured freshly, and at the 3rd, 6th and 9th day of storage. At each timepoint 6 °C, 12 °C, 20 °C storage temperatures were evaluated, so each of the vegetable, and the alterations were judged by 10 sample of storage trial. Storage was performed in fridges equipped with digital thermostats. In the case of each samples 2 pack (~150-280 g), or equal amount of raw, own-processed sample were stored.

The fresh cut, packed products were stored in their original modified atmosphere cover, while the raw, own-processed samples were covered by folpack. Initial weight of the samples were recorded, and followed during the storage, and wane loss were calculated. At each of the measurement days, the quality indicator trails were checked by me as hue, smell, consistency, taste.

Modified Spanyol method was applied for the determination of ascorbic acid content. Chlorophyll content was measured spectrophotometrically after extraction with pure acetone. Antioxidant-capacity was evaluated by DPPH-assay. Peroxidase enzyme-activities were recorded colorimetrically by the application of H₂O₂ substrate, and o-phenylene diamine reagent.

2. Attitude assessment of catering managers

Survey of canteens was performed in 2013 at the panel series organized by the Hungarian Catering-leader Association at many point of the country by a self-edited questionnaire.

Questions asked for the place of the canteen, the age group that is catered, the prove ratio of salad and other raw vegetables, and the causes of absence.

Valid questionnaires filled by 80 leader received, and were analysed by descriptive statistical methods.

3. Cost analysis in the catering

To perform financial analysis, full year self-cost calculating data and invoices of 3 institutions were collected from the year of 2012.

For the calculations, I had to get acquainted with the work processes and equipments of the canteens. In the analysis an institution from the capital city, a rural elementary school and a rural kindergarten were involved.

In each of the institutions the catering manager, the finance manager, the operatives of the equipments who have got knowledge on them helped my work.

Lettuce and carrot from the fresh cut, packed vegetables were chosen for the cost analysis.

Selection of these vegetables is validated by the fact that they can be consumed in fresh and single form, and they can be found as a component of salad mixes, in the form of packed products.

During cost analysis the traditional and the activity-based method were used to develop the method suited for the food plants evaluated by me.

Data processing and statistical analysis

To analyse the data by the time and the temperature of storage, obtained by laboratory measurements, two way analysis of variances (ANOVA) was performed followed by Bonferroni post-hoc test at 5% significance level ($p=0.05$). For the correlation analysis Spearman rank correlation was done. Each statistical test was executed by the Statistica 10.0 software (StatSoft Inc., Tulsa, Ok, USA)

Questionnaires filled by the catering managers were processed by the Microsoft Excel 2010 software, and descriptive statistics were applied to present them.

Results

At the initial of storage trial, the three vegetable species fresh, modified atmosphere packed samples shown lower free radical scavenger activity than the samples obtained from commercial trade, which were only washed at this time point.

During storage, decrease in antioxidant-capacity was observed in all cases, but the rates were different.

Unpacked fresh samples shown 105 I% - 96 I%, while the MAP samples shown only 40-50 I% antioxidant-capacity. At the 3rd day, the folpack covered cabbage sample stored at 6 °C lost more than the half of its antioxidant capacity (from 105 I% to 50.9 I%), while the

lettuce (from 96.2 I% to 58.3 I%) and corn salad (from 103.5 I% to 75.5 I%) shown a less drastic alteration.

At higher storage temperature the decrease in antioxidant-capacity is higher. At the 9th day, at 6 °C the corn salad shown the highest values, which was the half of the initial one (49 I%). It is followed by the lettuce, in which case the decrease was approximately 80% (20 I%). Highest alteration was observed in the case of white cabbage (from 105 I% to 13 I%).

Although MAP samples shown lower initial values, but they preserve the antioxidant-capacity better than the folpack covered

When we investigated the storage time and temperature correlation with the antioxidant-capacity, in the case of lettuce and cabbage we couldn't demonstrate significant correlation, while in corn salad samples the storage temperature shown significant, negative correlation with the aforementioned parameter ($r = -0.578$, $p = 0.014$).

Ascorbic acid, as a non-enzymatic antioxidant also shown different alteration trends, the modified atmosphere packed samples preserved better this component as well.

Lettuce possessed with the lowest ascorbic acid value (5.7 mg/100 g), and iceberg lettuce (4.6 mg/100 g) shown low value as well, while white cabbage contained the highest amount of ascorbic acid (60 mg/100 g).

In the case of lettuce and cabbage the MAP cover preserved better the ascorbic acid content compare to folpack.

Biggest decrease was observed at 20 °C.

At the 9th day the lettuce possessed 1 mg/100 g, the iceberg lettuce 4.3 mg/100 g content of ascorbic acid at 6 °C store.

MAP packed corn salad contained only the half of the ascorbic acid level of the unprocessed sample (25.3 mg/100 g).

At the 9th day, folpack covered sample 12 mg/100 g, while MAP packed sample shown 33 mg/100 g ascorbic acid.

Storage parameters strongly correlated with ascorbic acid content in the case of lettuce (storage time: $r = -0.536$, $p = 0.016$, storage temperature: $r = -0.762$, $p = 0.000$).

In the case of corn salad and cabbage such correlations could not be demonstrated.

Green pigment content was low (below 10 µg/mg) in the samples, except of corn salad (unprocessed sample 47 µg/mg, MAP covered 39 µg/mg).

Degradation of chlorophylls intensified at higher storage temperature. Corn salad only shown 14 µg/mg pigment content at the 9th day, 6°C store.

Storage conditions and chlorophyll pigment forms correlate differently in the three species.

Temperature and time both correlate well with the chlorophyll-a (Cla) in the case of corn salad (storage time: $r = -0.559$, $p = 0.018$, storage temperature: $r = -0.597$, $p = 0.01$).

Lettuce shown similarly strong correlation with both of pigment forms (storage time - Cla: $r = -0.486$, $p = 0.031$, storage temperature: $r = -0.533$, $p = 0.017$; and storage time – Chlorophyll-b: $r = -0.483$, $p = 0.033$, storage temperature: $r = -0.567$, $p = 0.01$).

In the case of cabbage none of the temperature or time correlates with the chlorophyll content. Peroxidase-enzyme activity in the fresh lettuce sample showed 76 U/g soluble activity, and 72 U/g membrane-bound activity.

While the bound isoform activity decreased significantly until the 3rd day, the soluble isoform activity increased to a high rate.

At the 9th day, at 6 °C, the soluble isoform activity was 13 U/g, and the bound-isoform activity was 6 U/g.

In fresh iceberg lettuce sample, both isoform activities were approximately 39 U/g. At higher temperature and the end of the storage trial, the bound form became dominant. At the 9th day, in the 6 °C sample, the soluble form activity was 20 U/g, and the bound isoform activity shown 39 U/g.

Correlation between storage conditions and enzyme activities brought the result that temperature influence strongly the soluble enzyme activity in both of the investigated species: In lettuce $r = -0.524$, $p = 0.019$, in white cabbage: $r = -0.47$, $p = 0.038$, in corn salad: $r = -0.554$, $p = 0.019$.

Bound isoform activities only shown significant correlation in corn salad ($r = -0.53$, $p = 0.018$). Storage time correlate only in lettuce sample with the soluble- and interestingly in the bound isoform ($r = -0.486$, $p = 0.031$) as well.

The 80 canteens were owned by the local-governments at 75% ratio, and almost at this percentage they were the self-operating part of the institution. 70% of the manpower was unqualified, and the preparation makers came among them. Canteens mostly use uncleaned raw materials. Fresh cut, packed salads rarely used, and just only in few industries, due to their high price.

During cost analysis, when I kept those cost factors that realized during the processes, beside the historical cost, in both cases the unprocessed products proved to be more economical.

Results indicate that lettuce costs 58.9 HUF/280 g - 93.9 HUF/280 g, while iceberg lettuce require 207.1 HUF/280 g - 295.2 HUF/280 g.

Costs of fresh and packed carrots show similar differences. The cost of fresh is 136.8 HUF/kg- 264.9 HUF/kg, while the packed form costs 733.4 HUF/kg-1027.8 HUF/kg.

The historical costs of fresh cut products are high, which can be lowered by the change of supplier. Cost of manpower is lower in the case of packed products, because only the removal of cover is required. Individual wage costs different from each other, as every worker has got unique productivity.

Rawly offered, mainly the leafy vegetables pose potential microbiological hazard sources. In our country, lettuce washed by submergence into fresh water. Besides HACCP, which adapted to institutions, there are no regulations that state the repeat number of this process, or the water change ratio. In trade, there are strictly regulated technological steps to achieve adequate quality assurance.

Conclusion

From the trial, where I assessed and compared the non-nutritive, quality effector components of raw and fresh cut vegetables in different storage conditions, I conclude that packed vegetables preserve at high-ratio their non-nutritive components when they stored at the recommended conditions.

I measured separately the less studied soluble, cytoplasm located-, and membrane bound peroxidase isoenzyme activities in lettuce, iceberg lettuce, white cabbage and corn salad

This distinct evaluation enables to find correlations between bound isoform and the organoleptic parameters of the plants that are affect the consumers.

The national, non-representative survey of mine investigated the fresh cut, packed vegetable application in canteens, which is a totally unassessed area of the field.

Results indicated that in catering, they rarely complete the low intake value of unprocessed vegetables with the packed products which hold lower microbiological risk. The reason is mainly the higher historical cost.

From the self-made, activity based flow chart of the lettuce and carrot preparing, which were confirmed by local observations and interviews, and from the financial data obtained from the institutions, the fresh cut, packed vegetables had got higher cost in all of the institutions compare to unprocessed vegetables.

The cause and effect correlation analysis based ABC theory, and the traditional cost calculating combination, which is not applied by the institutions, can be served as a model.

Many survey indicated that in lot of countries of the world, the vegetable consumption do not exceed the recommended values. In my thesis I highlighted a factor which pull back the increasing of consumption (workers, microbiological risk, costs), and was not analysed yet.

Related publications

Related to the thesis

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