Combined Effect of Packaging Method and Temperature on the Leafy Vegetables Properties

Masoud Shafafi Zenoozian

***Abstract*—This study was conducted to study the effect of modified atmosphere packaging (M.A.P.) on quality of fresh Spinach (*Spinacea oleracea L.*), Parsley *(Petroiselinum hortense*), and Dill (*Anethum graveolens*). These vegetables were packaged in polyethylene pouches. Vegetables were evaluated in three condition included perforated, active modified atmosphere, passive modified atmosphere at different temperature (5ºc, 10ºc, 20ºc, 25ºc).The following factors were determined: vitamin c, chlorophyll, weight loss, total count. Experimental results were shown that storage of parsley in modified atmosphere active was minimum loss weight and maximum chlorophyll retained. Parsley had the most molds in perforated packages maximum residual vitamin content was seen time which parsley was stored in MAP.**

***Index Terms*— Dill**, **Modified atmosphere packaging**, **Parsley**, **Spinach**

I. Introduction

Modified atmosphere packaging (M.A.P.) is regarded as a gas mixture, which has a atmosphere different from that of air, and which surrounds the produce to bring about beneficial effects, for extending the shelf life of the commodity [1]-[2]. The mixture atmosphere is made up primarily of oxygen, carbon dioxide and nitrogen [3]. The term, commodity - generated or passive modified atmosphere packaging to designate the matching of commodity respiratory characteristics with the gas permeability of package system so that a suitable equilibrium M.A.P. can passively evolve through the consumption of oxygen and the evolution of carbon dioxide in the respiration process [4]-[5]. On the other hand, an active modified atmosphere can be established by venting air from the package and by back flushing through a selected gas mixture. Products with natural defense structures can be preserved by M.A.P., the reduction of ripening of product by means of M.A.P. is beneficial for retaining the integrity of epidermal tissue and thus maintaining resistance to spoilage [6]. Higher carbon dioxide concentrations can inhibit aerobic microorganisms in M.A.P. Reduction of vegetable respiration rate has been occurred as result of the inhibition of the activity of oxidizes such as a polyphenol oxidize, ascorbic acid oxidizes and glycol acid oxidize [7]. Many researches have been done in field of modified atmosphere packaging. For example, M.L. Amodio, R. Rinaldi, and G. Colelli illustrated the application of M.A.P., 3 kPa O_2 plus 2 kPa CO_2, at 58°C during 10 days for a ready-to-cook fresh-cut vegetable mixture of parsley, beet, spinach, zucchini , pumpkin, carrot, celery, tomato, savoy cabbage, leek, onion, and rehydrated peas, and 'Borlotti' beans [8].As well as, M.I. Gil, F. Ferreres, and F.A. Tomas-Barberan. resulted that fresh-cut spinach involved ascorbic acid as a predominant form of vitamin C. However, a reduction in ascorbic acid and an increasing of dehydroascorbic acid was showed during storage. The accumulation in dehydroascorbic acid was more prominent in M.A.P. and obtained in a higher vitamin C level for spinach in M.A.P. than air [9].Meanwhile,Y. Mizukami, T. Saito, and T. Shiga. indicated that air plus 3–5 kPa CO_2 was helpful for spinach [10].However, R.E. Hardenburg, A.E. Watada, and C.Y. Wang, exhibited that storage in 11% CO_2 + 10% O_2 improved to keep the green color of the leaves during storage [11].Whereas, A .Simón and E. Gonzalez-Fandos, monitored the sensory and microbiological quality of fresh peeled white asparagus packaged in two different types (film A: 7% CO_2 and 15% O_2 and film B: 2% CO_2 and 20% O_2) and stored at two different temperatures (5 °C and 10 °C) for up to 14 days. They resulted the shelf life was 6 days at 10 °C, the loss of freshness was the main cause of quality loss, as showed by color darkening. Also, fresh appearance was kept better at 5 °C than at 10 °C, being microbial spoilage the main limiting factor. The atmosphere was produced by film A, protected from spoilage and hold the acidity of asparagus better than the atmosphere generated by film B. The shelf life of asparagus packaged in film A and stored at 5 °C was 14 days [12].Even though, F. Charles, C. Guillaume and N. Gontard, studied the quality changes of fresh endives undergoing modified atmosphere packaging. Three packaging conditions were examined at 20 °C: a macro perforated oriented polypropylene pouch was considered as unmodified atmosphere packaging (UAP) and a low density polyethylene pouch with or without an individual oxygen scavenger sachet to create active or passive modified atmosphere packaging , respectively. By means of a steady modified atmosphere combination of 3 and 4.5 kPa O_2 and CO_2, respectively, the effect of passive M.A.P. on color changes in endives was like to that of UAP. Advantage of M.A.P. of endives was obtained via an oxygen scavenger, i.e. active M.A.P. did not modify oxygen and carbondioxide partial pressure during the steady state period, versus to passive M.A.P., but involved a 50% decrease of the transient time. This drop conducts to a critical lag in greening and browning of endives [13].Despite the fact, P. A. Gómez and F. Artés**,** investigated the improved keeping quality of

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minimally fresh processed celery sticks by modified atmosphere packaging. They showed both M.A.P. treatments developed the sensory quality, without the loss of green color, reduced the progress of pithiness and retarded the growth of microorganisms. In any treatment neither off-odours nor off-flavours was observed. After 15 days at 4 °C within the oriented polypropylene samples, a steady-state atmosphere of 6 kPa O_2+7 kPa CO_2 was obtained and celery sticks stored under these bags exhibit the best quality [14].On the other hand, when it is not intended to create a modified atmosphere, the main concern is to avoid anoxic conditions and condensation of water vapor inside the package. This is most easily achieved either by incomplete sealing or perforation is to punch holes or perforations, according to, the weight and respiratory requirement of the produce [15].Much research has been conducted by using perforated packages. For instance, E. R. Brack, used perforated polyethylene for watercress, parsley and mint at different conditions. They resulted that respiration rates decreased in the order parsley greater than watercress greater than mint [16]. In another research, untrimmed parsley and celery were packaged in polyethylene films and stored for less than or equal 120 days at 0-2 ºC and 85-93% Relative Humidity. Utilization of polyethylene pouches reduced the weight loss of green bean and spinach that kept at 20ºc, and reduced chlorophyll loss of green bean at 10ºc and that of spinach at 20ºc. Ascorbic acid was preserved by packaging of green beans and spinach kept at 10ºc [17]. Modified atmosphere packaging reduces respiration rate, improves chlorophyll and decrease the rate of microbial growth [18]-[19]. Also, Costa *et al.* studied about influence of passive and active modified atmosphere packaging conditions on fresh-cut zucchini and ready-to-eat table grape [20]-[21].As well as, recently, a mathematical packaging model was designed for fresh-cut fruits and vegetables with microperforated [22].

In addition, a research was conducted in field of antioxidant activity of minimally processed vegetables undergoing modified atmospheres [23]. Whereas, Jia *et al.* investigated the effect of modified atmosphere packaging on visual quality of broccoli florets [24].Afterward, a case study was done about modified atmosphere packaging of green bell peppers [25]. This work investigated the use of low density polyethylene packages to monitor changes of some properties; i.e., vitamin C, chlorophyll relative amount, weight loss and total count of packaged leafy vegetable undergoing different packaging methods, such as perforated, passive modified atmosphere and active modified atmosphere packaging at different temperature.

II. Materials and Methods

Spinach, Parsley, and Dill were purchased from a local market, dipped for 1 min in water and disinfected for 5 min in a 50 PPM sodium hypochlorite solution at 10ºc.After that, vegetables were rinsed under water for 2 min, and separated into subplots as three replicates of packaged and unpackaged samples for each temperature-time treatment. For perforated packaging, samples were placed into the low density polyethylene pouch (mashad plaust company, Iran) with "20cm × 8 cm," dimension and 5 mil thickness that was punched as eighteen 6mm diameter holes.

As well as, vegetables were packaged in modified atmosphere by placing them in low density polyethylene pouch, then replacing the air through the pouch by gas mixture (7 - 10%, O2, 7-10% CO2, and 80-85% N2) and heat sealing the pouches by means of M.A.P. equipment(M.Shafafi Zenoozian, Iran). The samples were located at 5ºc, 10ºc, 20ºc and 25 ºc during one week. The following quality properties were monitored. Chlorophyll content was ascertained by chlorophylemeter as spad unit (Model:OSK 10447,Japan). Vitamin C was measured by using 65507/2 - 1984 ISO method [26]. Population of microorganisms was estimated periodically during storage time; the culture media was nutrient agar and sabort dextrose agar for total count and mold respectively.

III. Results and Discussions

As can be seen, the Fig.1 indicates that weight loss had fluctuation trend in regard to the types of vegetables. Generally, Spinach and parsley had maximum and minimum weight loss respectively. It can be inferred that parsley has thick cuticle, low level free water and stoma numbers per surface unit in contrast with another vegetables. Regarding the Fig.2, it can be clearly realized that active modified atmosphere packaging had at least loss weight among the vegetables. Because of the respiration rates of vegetables were restricted in active modified atmosphere, also carbohydrate resources were consumed slightly in this condition, then weight loss was at least in active modified atmosphere.

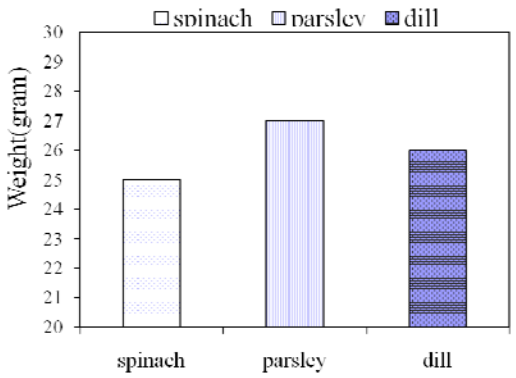

Figure 1. Weight loss according to the types of vegetables

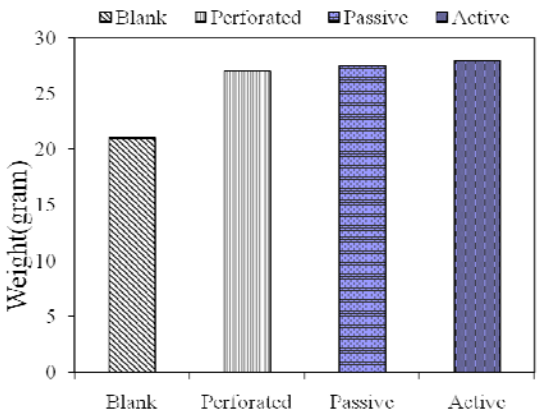

Figure 2. Effect of packaging on weight loss

Having considered the Fig.3, it can be easily inferred that chlorophyll content had a significant reducing trend in three types of vegetables from 5°c to 25°c.As can we seen, parsley had highest chlorophyll content at 5c meanwhile dill showed lowest chlorophyll content at 25°c.This results turn back the initial chlorophyll content and different storage temperature. Maybe, it can be assumed that enzyme chlorophyllase had low level activity, then chlorophyll residue would be more than that of vegetable.

With a brief glance in Fig.4, it can be vividly perceived that vitamin content had obviously descending rate in all vegetables during one week.

As far as the Fig. 5 is regarded, passive modified atmosphere packaging preserve vitamin content more than another method on first day. On the other hand unpacked samples depicted lowest vitamin C after one week.

Having surveyed in Fig. 6, spinach active modified atmosphere had a maximum total count. Meanwhile, dill perforated package reported minimum total count. The active MA condition would be suitable for anaerobic and facultative anaerobic.

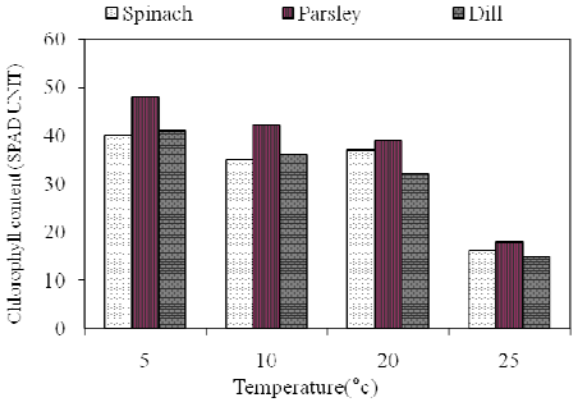

Figure 3.Chlorophyll content of vegetables at different temperatures

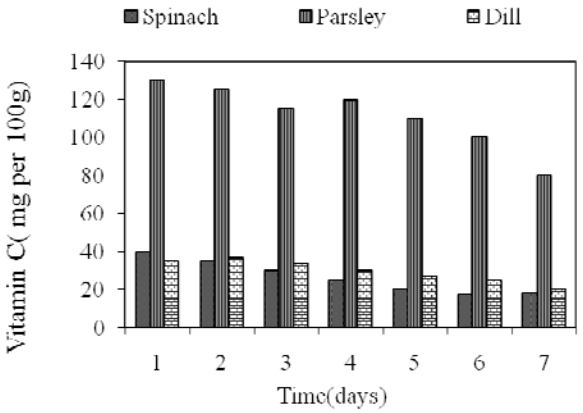

Figure 4. Variation vitamin C content during one week

Spinach had the most total count after seventh day; on the other hand dill depicted the least amount at first day. Reasons were included: greater free surface, free water and unfavorable situations at transportation and/or postharvest contamination.

As can be seen, Fig.7 indicates the effect of temperature-vegetable interaction on the total count of mold. With a short glance in Fig.7, it can be indicated that total count had significant an arising rate from 5°c to 25°c in all vegetables. Spinach showed maximum total count at 25c.dill had minimum total count at 5°c.

Spinach indicated the most molds after 7 days, however, dill had at least on first day. It can be supposed that the load of mold was higher that dill. Also, the mold population, significantly, rose during storage time.

In case of parsley, the wilting condition was at least at the first day. Finally all vegetables were the same effect at one day. The wilting condition was related to spinach at the seventh day, because, spinach had more chlorophyll more resistant structure and the less free water according to other vegetables. Since the spinach was the more free water, available these results would improbable.

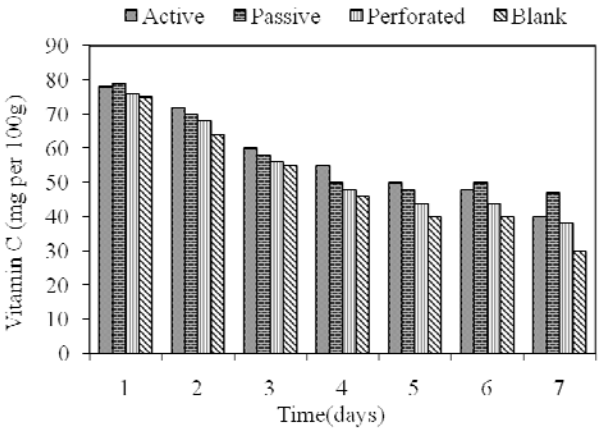

Figure 5. Effect of packaging -time interaction on the vitamin c content

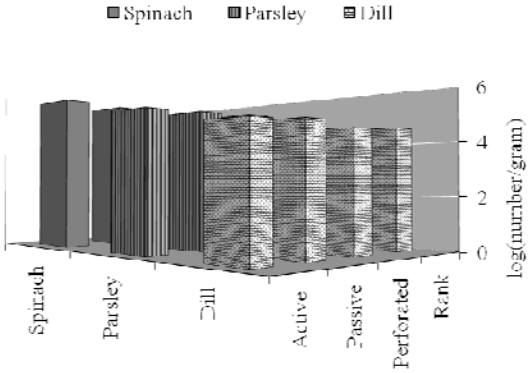

Figure 6. Effect of packaging-vegetable interaction on the total count

Temperature- package- time effect interactions were compared and resulted that modified atmosphere packaging (passive and active method) was the same effects on wilting condition at 10 ºc at the first day and were not significant difference. Furthermore, modified atmosphere packaging (active method) was the most wilting condition at 25 ºc at the seventh day. It was recommended that to maintenance the quality of vegetable in modified atmosphere packaging (passive method) was the best temperature at 10ºc.

IV. CONCLUSIONS

Generally, it can be stated that Spinach and parsley had maximum and minimum weight loss respectively. Also, active modified atmosphere packaging had minimum loss weight in all vegetables. It can be concluded that dill showed lowest chlorophyll content at 25°c. As well as, modified atmosphere packaging preserve vitamin C content more than another method. As the final analysis, It can be inferred that the active MA condition would be suitable for anaerobic and facultative anaerobic microorganisms.In addition, spinach and dill showed maximum and minimum total count respectively.

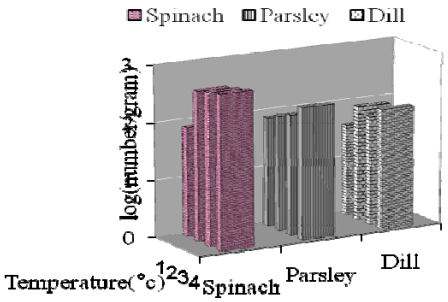

Figure 7. Effect of temperature- vegetable interaction on the total count of mold

All in all, it can be indicated that M.A.P. has these advantages: development fresh foods, no preservatives, healthy appearance, improved hygiene, better quality, reduced wastage. It can be suggested that to investigate prediction the physical properties by artificial neural networks. Further work is now underway to develop an approach (via the utilization of artificial neural network simulation) to predict the physical properties of vegetables when the values of characteristics are given.

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