Effect of temperature and humidity on the transpiration rate of the whole mushrooms

Water loss or transpiration is an important physiological process that affects the main quality characteristics of fresh mushrooms, such as saleable weight, appearance and texture. A loss in weight of only 5% may cause fresh produce to lose freshness and appear wilted and it is an important parameter to be considered while designing packaging. The researchers at Department of Process and Chemical Engineering, University College Cork, Ireland developed a setup to monitor the mass loss of mushrooms under various surrounding temperatures (4, 10 and 16°C) and relative humidity (76, 86 and 96%). Mass loss of whole button mushrooms (*Agaricus bisporus*) was measured and transpiration rates were calculated at all the experimental conditions tested. Transpiration rate ranged from 0.14-2.5 mg/cm²/h over all the combinations of temperature and humidity tested. Humidity was the variable with the greatest effect on transpiration rate. A mathematical model was developed to understand the evolution of water loss with temperature and relative humidity. The fitting was very good and the distribution of residuals was normal. The model was validated at 13°C and good agreement was found between experimental and predicted data [Mahajan PV, Oliveira FAR and Macedo I, Effect of temperature and humidity on the transpiration rate of the whole mushrooms, *J Food Eng*, 2008, 84(2), 281-288].

Effectiveness of organic acid, ozonated water and chlorine dippings on microbial reduction and storage quality of fresh-cut Iceberg Lettuce

The comparative effects of organic (citric and lactic) acids, ozone and chlorine on the microbiological population and quality parameters of fresh-cut lettuce during storage were evaluated by the researchers at Turkey. Dipping of lettuce in 100 mg/l chlorine solution reduced the numbers of mesophilic and psychrotrophic bacteria and members of family *Enterobacteriaceae* by 1.7, 2.0 and 1.6 log₁₀ colony-forming units (CFU)/g, respectively. Treatment of lettuce with citric (5 g/l) and lactic (5 ml/l) acid solutions and ozonated water (4 mg/l) reduced the populations of mesophilic and psychrotrophic bacteria by 1.7 and 1.5 log₁₀ CFU/g, respectively. Organic acid dippings resulted in lower mesophilic and psychrotrophic counts than ozonated water and chlorine dippings during 12 days of storage. Lactic acid dipping effectively reduced (2.2 log₁₀ CFU/g) and maintained low populations of *Enterobacteriaceae* on lettuce for the first 6 days of storage. No significant (*P* > 0.05) changes were observed in the texture and moisture content of lettuce samples dipped in chlorine, organic acids and carotene and vitamin C values of fresh-cut iceberg lettuce did not change significantly (*P* > 0.05) until day 8. Thus, lactic and citric acids and ozonated water dippings could be alternative treatments to chlorine dipping to prolong the shelf-life of fresh-cut iceberg lettuce [*Akbas Meltem Yesilcimen and Ölmez Hülya, Effectiveness of organic acid, ozonated water and chlorine dippings on microbial reduction and storage quality of fresh-cut iceberg lettuce, J Sci Food Agric*, 2007, 87(14), 2609-2616].

Antioxidative performance of Tomato extracts

Two extraction methods employing tetrahydrofuran and phosphate buffer (pH 7.4), respectively were used by the researchers at National Chung-Hsing and Da-Yeh University, Taiwan to process tomatoes. The antioxidant contents and antioxidative properties of extracts of four tomato cultivars were measured. To evaluate the overall antioxidative capacity of the tomato extracts, an antioxidative performance index (API) was used, defined as the average of four antioxidative assays, i.e. relative reducing power, ferrous ion-chelating ability, 2, 2-diphenyl-1-picrylhydrazyl free radical-scavenging
activity and superoxide radical-scavenging activity. A linear correlation between the total antioxidant content and API of tomato extracts found was independent of the extraction method and tomato cultivar. Thus, the concept of representing multiple antioxidant activities by a single index is useful for evaluating the overall antioxidative capacity of antioxidants in tomatoes [Chang Ching-Hui and Liu Yung-Chuan,

**Effect of high pressure/high temperature processing on firmness of carrot tissue**

Thermal processing for food preservation results in undesired softening of fruits and vegetables. Hence, to explore the potential of high pressure sterilization in food processing, the effects of combined high pressure/high temperature (HP/HT) treatments on carrot pectic polysaccharides and the related textural properties were investigated and compared by scientists at Centre for Food and Microbial Technology, Katholieke Universiteit Leuven, Kasteelpark Arenberg, Leuven, Belgium with that of samples thermally processed at atmospheric pressure. Disks of fresh carrot (Daucus carota Linn. cv. ‘Yukon’) tissue were subjected to three different treatments (80°C-0.1MPa, 100°C-0.1MPa and 80°C-600MPa) for varying time intervals. Subsequently, the residual texture and microstructural changes of the carrots were evaluated. Alcohol-insoluble residues were prepared from the samples and sequentially fractionated with water, cyclohexane-trans-1,2-diamine tetra-acetic acid (CDTA) and Na₂CO₃ solutions. Thermal treatments at 0.1MPa caused extensive tissue softening. This was marked by increased cell separation, an increase in water soluble pectin (WSP) paralleled by a decrease in chelator (CSP) and sodium carbonate (NSP) soluble pectin. HP/HT treated carrots showed minimal softening and negligible changes in intercellular adhesion. This was accompanied by a significant reduction in the degree of methyl esterification of pectin, low WSP in contrast to the high CSP and NSP fractions, minor changes in the different pectin fractions during treatment, and a substantial amount of pectin in the fractionation residue. There was a clear difference between HP/HT and thermally processed carrot pectin; HP/HT showing pronounced texture preservation [Roeck Ans De, Sila Daniel N, Duvetter Thomas, Loey Ann Van and Hendrickx Marc, Effect of high pressure/high temperature processing on cell wall pectic substances in relation to firmness of carrot tissue, Food Chem, 2008, 107(3), 1225-1235].
Mungbean (*Phaseolus radiatus* Linn. var. *typicus* Prain), rice bean (*Phaseolus calcaratus* Roxb.), soybean (*Glycine max* Merr.), small bean (*Phaseolus radiatus* Linn. var. *aurea* Prain) and wild soybean (*Glycine soja* Sieb & Zucc.) are common edible beans. They contribute many phytoneutrients including immunomodulatory nutrients such as vitamins (A, B2, C and E) and minerals (copper, zinc, iron, selenium). To explore the health-modulating constituents of

**Immunomodulatory activities of edible beans and related constituents from soybean**

common edible beans, their immunomodulatory activity on human peripheral blood mononuclear cells was evaluated by scientists at Taiwan. Studies were conducted on lymphocyte transformation by BrdU immunoassay, secretion of interferon-gamma (IFN-γ) and interleukin 10 (IL-10) and elucidation of the responding cells by flow cytometry. The results at 20 µg/ml showed that genistein, phytic acid and syringic acid induced a Th1-predominant immune response because they significantly suppressed the secretion of IL-10 and augmented the IFN-γ production. The study concludes that several non-nutritional ingredients of soybean such as flavonoids, plant acids and plant hormones most likely to be important in modulation of human immunity [Chen Ng Jaw-Ming, Chiang Wen and Chiang Lien-Chai, *Immunomodulatory activities of edible beans and related constituents from soybean, Food Chem*, 2007, 104 (2), 613-618].

**Use of ozone in a Lettuce-washing process: an industrial trial**

Bacteria such as *Escherichia coli* and *Salmonella* spp. may cause serious problems for the quality maintenance of pre-packaged lettuces. Therefore, the researchers at Germany evaluated the bactericidal effect of ozonated water in the washing of iceberg lettuce. For this purpose an ozone generator was integrated into a commercial lettuce-washing facility. Lettuce samples were removed from this process and analysed for mesophilic total viable count (TVC), *E. coli*, *Salmonella* spp., vitamin C and sugar content. The analyses were carried out either directly after washing or at the end of best-before date, in which lettuces were stored at 4ºC for 6 days. Water samples were analysed for total organic carbon content and pH. Through the addition of ozone to the wash water the quality of lettuce during storage time was unaffected while there was only a limited observed decrease in populations of microorganisms [Hassenberg Karin, Idler Christine, Molloy Eleanor, Geyer Martin, Ploch Matthijs and Barnes Jeremy, *Use of ozone in a lettuce-washing process: an industrial trial, J Sci Food Agric*, 2007, 87(5), 914-919].

**Water supply and growing season influence glucosinolate concentration and composition in Turnip root**

The researchers at China and Germany conducted studies to determine whether growing season, water supply and their interaction influence glucosinolate (GSL) concentration and composition in turnip roots (*Brassica rapa* Linn. ssp. *rapifera* Linn.). Field experiments on a loamy soil in Großbeeren, Germany, were conducted in the spring-summer (SS), summer-autumn (SA) and autumn-winter (AW) growing seasons. Each experiment included three water-supply treatments with 25, 50 and 75% of available soil water (ASW) as lower thresholds. It was noted that the total GSL concentration in turnip roots was 1774-3221 µmol/kg fresh matter (FM) and the dominant GSL was aromatic gluconasturtiin (GST) with concentrations of 1004-1628 µmol/kg FM in turnip roots. Total, aliphatic and some specific individual GSLs in turnip roots were significantly influenced by water supply, growing season and their interaction, due to the variations of the
Chlorine dioxide (ClO₂) gas is a strong oxidizing and sanitizing agent that has a broad and high biocidal effectiveness and big penetration ability; its efficacy to prolong the shelf-life of a minimally processed (MP) vegetable, grated carrots (*Daucus carota* Linn.), was tested by scientists at Belgium and Venezuela. Carrots were sorted, their ends removed, hand peeled, cut, washed, spin dried and separated in 2 portions, one to be treated with ClO₂ gas and the other to remain untreated for comparisons. MP carrots were decontaminated in a cabinet at 91% relative humidity and 28°C for up to 6 min, including 30s of ClO₂ injection to the cabinet, then stored under equilibrium modified atmosphere (4.5% O₂, 8.9% CO₂, 86.6% N₂) at 7°C for shelf-life studies. ClO₂ concentration in the cabinet rose to 1.33mg/l after 30s of treatment and then fell to nil before 6 min. The shelf-life study included: O₂ and CO₂ headspace concentrations, microbiological quality (mesophilic aerobic bacteria, psychrotrophs, lactic acid bacteria and yeasts), sensory quality (odour, flavour, texture, overall visual quality and white blushing) and pH. ClO₂ did not affect respiration rate of MP carrots significantly (≤0.05), and lowered the pH significantly (≤0.05). The applied packaging configuration kept O₂ headspace concentrations in treated samples in equilibrium and prevented CO₂ accumulation. After ClO₂ treatment, the decontamination levels (log CFU/g) achieved were 1.88, 1.71, 2.60 and 0.66 for mesophilic aerobic bacteria, psychrotrophs and yeasts, respectively. The initial sensory quality of MP carrots was not impaired significantly (≤0.05). A lag phase of at least 2 days was observed for mesophilic aerobic bacteria, psychrotrophs and lactic acid bacteria in treated samples, while mesophilic aerobic bacteria and psychrotrophs increased parally. Odour was the only important attribute in sensory deterioration, but it reached an unacceptable score when samples were already rejected from the microbiological point of view. The shelf-life extension was limited to one day due to the restricted effect of the ClO₂ treatment on yeast counts. Nevertheless, ClO₂ seems to be a promising alternative to prolong the shelf-life of grated carrots [Gómez-López VM, Devlieghere F, Ragaert P and Debevere J, Shelf-life extension of minimally processed carrots by gaseous chlorine dioxide, *Int J Food Microbiol*, 2007, 116 (2), 221-227].
The scientists at Department of Raw Materials and Processing of Fruit and Vegetables, University of Krakow, Krakow, Poland determined the content of ash and P, K, Ca, Mg, Na, Fe, Zn, Mn, Cu, Cr, and Ni in broad bean and pea seeds of milk-wax maturity and in French-bean pods. The investigation covered the raw material; blanched and cooked material and frozen products prepared from blanched or cooked vegetables after 12 months of storage at -30°C. Frozen products were prepared for consumption either by cooking or by defrosting and heating in a microwave oven. The smallest general loss of constituents caused by blanching was found in broad bean seeds, while the greatest loss was in French-bean pods. Cooking the same batch of the raw material increased the loss by 0-14%, depending on the species and the analysed element. In 100g of product, prepared for consumption using the modified method (cooking-freezing-defrosting and heating in a microwave oven), the content of ash, phosphorus, potassium, magnesium, iron, zinc, manganese, and copper was greater by 4-12, 2-11, 16-36, 17-31, 7-23, 4-12, 4-16, and 3-13%, respectively as compared with products obtained using the traditional method ( Blanching-freezing-cooking). The recorded level of the remaining elements was not always higher: in the case of calcium the difference varied from -2% to +7%; of sodium from -11% to +24%; of chromium from -14% to +9%; and of nickel from -4% to +54%.

[Zofia Lisiewska, Jacek Slupski, Waldemar Kmiecik and Piotr Gebczyński, Availability of essential and trace elements in frozen leguminous vegetables prepared for consumption according to the method of pre-freezing processing, Food Chem, 2008, 106(2), 576-582].

Gaseous ClO₂ was evaluated by scientists at Belgium and Venezuela for effectiveness in prolonging the shelf-life of minimally processed (MP) lettuce and MP cabbage, previously immersed in a cysteine solution in order to inhibit browning occurring during ClO₂ treatment. Each vegetable was shredded, washed and separated in two portions, one to be treated with ClO₂ gas and the other to remain untreated as reference sample. The batch to be treated with ClO₂ gas was immersed for 1 min in a 0.5% solution of HCl-cysteine monohydrate. Then both batches were spun dried. MP vegetables were decontaminated in a cabinet at 90-91% relative humidity and 22-25°C up to 10min, including 30s of ClO₂ injection into the cabinet. The ClO₂ concentration rose to 1.74mg/l (MP lettuce) and 1.29mg/l (MP cabbage). Samples were stored under modified atmosphere at 7°C for shelf-life studies. Changes in O₂ and CO₂ headspace concentrations, microbiological quality [aerobic plate count (APC), psychrophilous, lactic acid bacteria and yeasts], sensory quality and pH were followed during storage. The respiration rate of the minimally processed vegetables was significantly increased by the ClO₂ gas treatment only in the case of MP cabbage (P<0.05). The gas treatment...
Vegetables

Interactive effects of phosphorus, nitrogen and thiourea on Cluster bean under rainfed conditions

The researchers at Central Arid Zone Research Institute, Jodhpur, India conducted two-years field study with Cluster bean (Cyamopsis tetragonoloba (Linn.) Taub. cv. ‘RGC-936’) under rainfed conditions. The experiments were set up in a split-split-plot design with three levels of phosphorus (0, 20 and 40kg/ha) and two levels of nitrogen (0 and 20kg/ha) with and without thiourea application (seed treatment with 500mg/kg followed by two foliar sprays of 1000 mg/kg each at 25 and 40 days after sowing). The years varied in their pattern of precipitation and consequently in the available soil moisture at different growth stages. Phosphorous (P) and nitrogen (N) application either alone or in combination with thiourea resulted in significantly higher net photosynthetic rates and concentrations of chlorophyll, starch, soluble protein and total free amino acids as well as nitrate reductase activity compared to control plants at both vegetative and flowering stages. However, the magnitude of favourable changes varied with soil moisture due to varying rainfall and the effects of N, P and thiourea were generally more pronounced in the vegetative stage. Seed yield, dry-matter production, harvest index and water-use efficiency were significantly enhanced by the above mentioned treatments. The favourable effects of the treatments were realized through significant improvements of metabolic efficiency and maintenance of higher photosynthesis and nitrate reductase activity for more efficient N utilization. It is concluded that the improvement of P and N status of arid-zone soils coupled with thiourea application can significantly improve the yield of cluster bean under rainfed conditions, though the potential gains may vary with soil-moisture availability [Burman Uday, Garg Balvinder Kumar and Kathju Shyam, Interactive effects of phosphorus, nitrogen and thiourea on cluster bean (Cyamopsis tetragonoloba Linn.) under rainfed conditions of the Indian arid zone, J Plant Nutr Soil Sci, 2007, 170(6), 803-810].

reduced initially APC and psychrotroph count of MP lettuce and APC, psychrotroph counts, yeast counts and pH of MP cabbage ($P<0.05$). ClO$_2$ treatment did not cause initially any significant ($P<0.05$) sensorial alteration, except for a weak off-odour in MP lettuce. Interestingly, no browning was observed after treating, which can be accounted to the use of l-cysteine. Although an initial microbiological reduction was observed due to ClO$_2$ gas treatment, APC and psychrotroph counts reached in the samples treated with ClO$_2$ higher levels than in those non-treated with ClO$_2$ before the third day of the shelf-life study. Untreated and treated samples of MP lettuce were sensorial unacceptable due to bad overall visual quality after 4 days, while treated and untreated MP cabbage remained sensorial acceptable during the 9 days of the study. L-Cysteine reduced ($P<0.05$) the decontamination efficacy of ClO$_2$ when applied to MP cabbage but not in the case of MP lettuce. Gaseous ClO$_2$ failed to prolong the shelf-life of MP lettuce and MP cabbage. Nonetheless, these results prove that it is possible to inhibit browning caused by ClO$_2$ [Gómez-López Vicente M, Ragaert Peter, Jeyachandran Visvalingam, Debevere Johan and Devlieghere Frank, Shelf-life of minimally processed lettuce and cabbage treated with gaseous chlorine dioxide and cysteine, Int J Food Microbiol, 2008, 121(1), 74-83].