2.2 The Measurement of Osmotically Persimmon Quality

Osmotically treated product qualities from treatment of (-1,-1), (0, 0) and (1, 1) code value which represented the combination of sucrose and NaCl concentrations as following: 34.4 and 1.47 g/100g, 45 and 5 g/100g and 55.6 and 8.53 g/100g, respectively were determined in term of texture, color, water activity, sucrose content and NaCl content. The osmotically treated disk and cube samples were withdraw from 6 h of immersion time whereas the whole fruit samples were soaked for 48 h. For microstructure observation, osmotically treated persimmon cube from treatment of (-1,-1), (0, 0) and (1, 1) code value were withdraw from interval immersion time of 30, 120 and 360 min.

2.2.1 Texture Analysis

Firmness measurements were taken as the first peak force value obtained during the test to penetrate the fruit. The test is a way of representing how the texture might feel if a person were to bite down on it, and was used in an attempt to detect how texture changes during osmotic treatment process.

Figure 34 shows the firmness value of fresh and osmotically dehydrated persimmon disks, cubes and whole fruits. It can be seen that the firmness of the samples after the osmotic treatment are decreased as compares to the fresh sample. So, the products after osmotic treatment are much softer than the fresh ones. Due to the main changes induced by osmotic treatment affecting mechanical behavior of plant tissues are loss of cell turgor, an alteration of middle lamella (Alzamora *et al*, 1993), alteration of cell wall resistance, establishment of water and solute concentration profiles (Salvatori *et al*, 1998). So, on the basis of the above reason, the expected changes in mechanical response provoked by osmotic processes will be a decrease in firmness. Different process conditions can excite the mechanical change in difference degree. It was found that all sample shape (disk, cube and whole fruit) treated with the high level of osmotic concentration solution (code +1, +1) were the softest and those treated by solutions treatment at low and medium level (code-1,-1 and code 0,0) were non significant different in firmness value. However, all osmosed product were represented only a bit change in firmness compared to the fresh sample; the softness associated with loss of fruit turgor seems to partially compensate with hardening due to removing of water. In fact the factor of sample size and shape are also influence on mechanical change during osmotic treatment. This could be due to the different in concentration profiles developed in each sample shape, since driving force is very different in each sample shape or to a different degree of alteration of cell plant tissue through the osmotic treatment process. The firmness of osmotically whole fruit samples are ranged between 13.16 and 16.25 N greater than osmosed disk and cube samples which are ranged between 9.32 and 12.76 N.

2.2.2 Color Analysis

Significant differences were found between treatment regarding all color values (L*, a* and b*) as shown in Figures 35-37. A significant decrease in L* values was observed between fresh and osmotic pretreated sample (Figure 35), marking the product darken. A significant increase in a* and b* values (Figures 36 and 37) were observed in samples that were osmotic pretreated. This increase in a* and b* values can be contributed to brownish-yellow dominate the color of persimmon. The highest a* value was observed in the whole fruit samples that were treated with high level of osmotic concentration solution (code +1, +1). The highest b* values was observed in the cube samples that were treated with the medium level of osmotic concentration solution (code 0, 0). The increase in redness and yellowness is seems to be a result of matrix concentration and solid uptake. Alline *et al*. (2003) and Forni *et al*. (1997) also observed the similar behavior for osmotically treated apricots and papaya, respectively. Moreover, a greater redness and yellowness represents a more pure and intense color (Pormeranz and Meloan, 1971). It can be seen the significant increase with increasing the osmotic solution concentration, denoting color intensification.

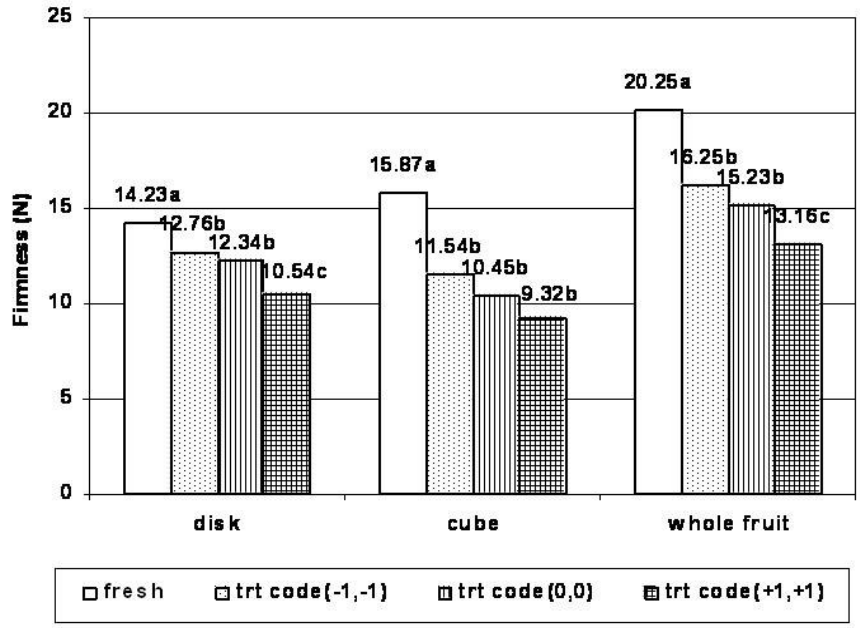


Figure 34 Firmness of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.

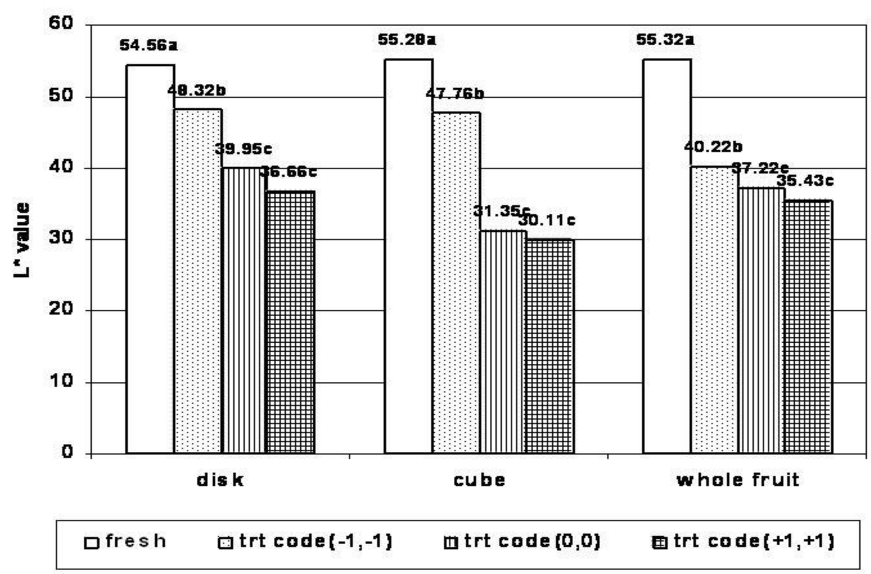
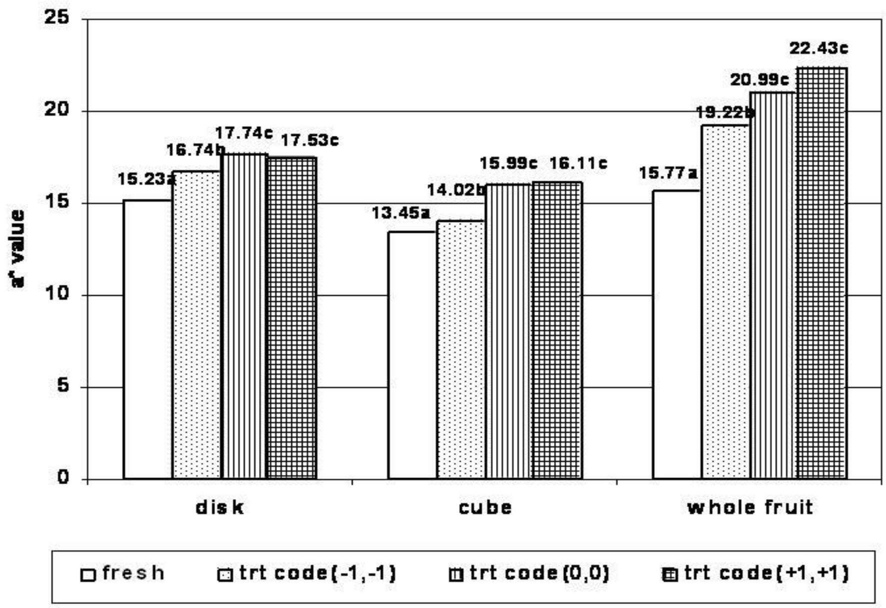
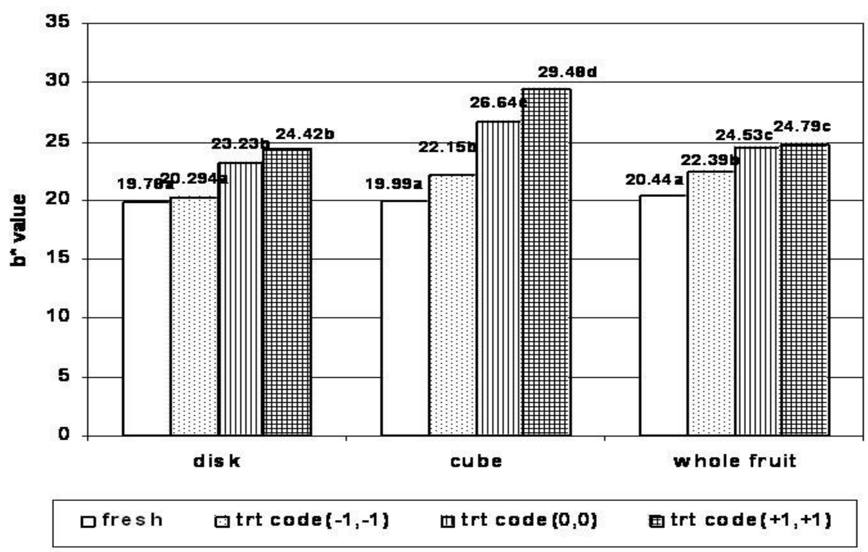


Figure 35 L* value of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.



<u>Figure 36</u> a* value of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.



<u>Figure 37</u> b* value of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.

2.2.3 Microstructure Observation

Sample microstructure was observed by confocal scanning laser microscopy (CSLM). Cell wall of material was labelled by staining the cell walls with 0.1% congo red which incubated in solution for 10 min. Figure 38 a) shows the tissue of fresh persimmon. It showed conspicuous intercellular spaces. Cells appeared turgid with an apparent consistent cell wall structure. Cells were more or less regular in rounded shape, in general isodiametric. Cells arrange in net- like pattern and attached along extended contact areas and tissue is densely packed.

When plant material is exposed to concentrated aqueous solutions of low molecular substances which exhibit an osmotic pressure, a release of water from the product with a simultaneous impregnation of the plant material with the solute will take place. The structure property of the osmotically treated product will depend on the changes of composition due to the impregnation, the impact of the process on the cell wall and middle lamella, as well as on the degree of damage to the plasma membrane due to processing (Ferrando and Spiess, 2001).

As long as the tissue membranes are intact, osmosis will be the mechanism controlling any mass transfer phenomena initiated by concentration differences with the plasma membrane as the major resistance to mass transfer (Le Maguer and Yao, 1995). Figure 38 compares micrographs obtained in confocal scanning laser microscopy for fresh and osmosed cube tissues immersed in maximum osmotic solution concentration which contained 55.6 g/100g sucrose and 8.53 g/100g NaCl (code value +1,+1) at various time. In Figure 38 b), it clearly seen that the osmosed cell became polyhedral after immersed for 30 min. Some collapse of tissues and folding of cells walls were observed. After treated for 120 min, it was found a small reduction in intercellular spaces. Samples treated for 360 min., cell structure appeared clearly affected by plasmolysis and some shrinkage of the tissue and reduction of intercellular spaces were observed.

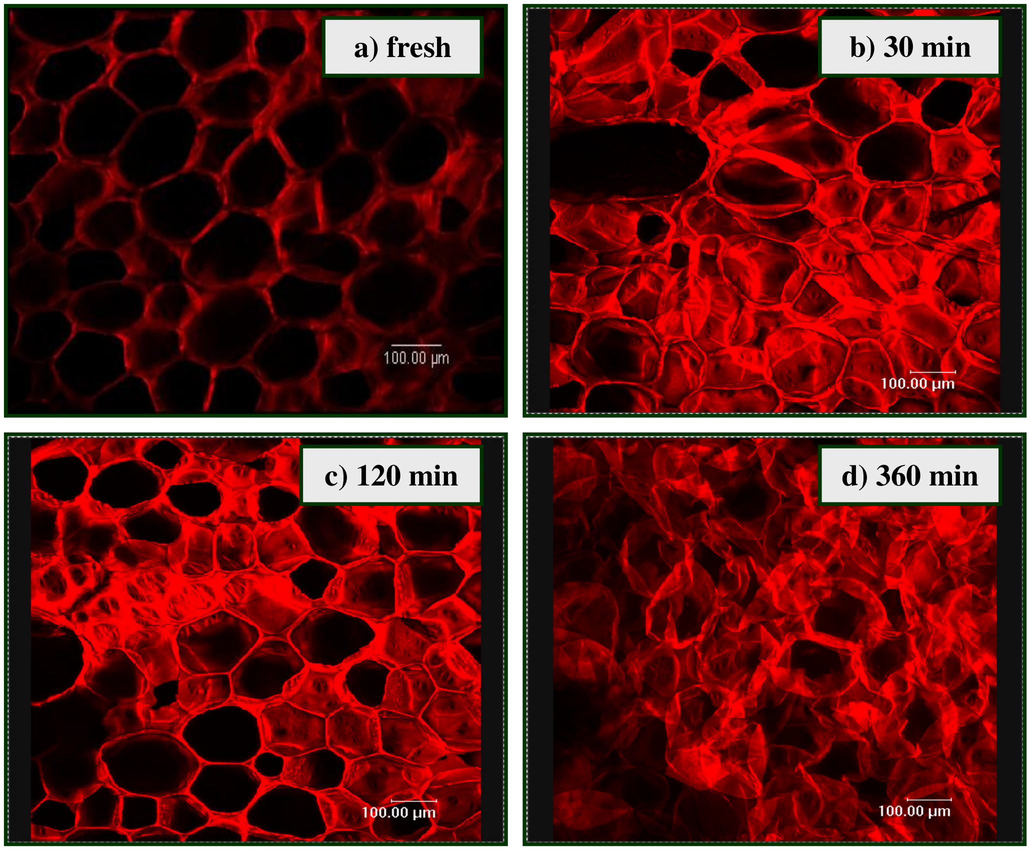


Figure 38 Confocal scanning laser micrograph of a) fresh and osmotically treated persimmon cube tissue at different immersion time of b) a) 30 min b) 120 min and c) 360 min in osmotic solution contained 55.6 g/100g sucrose and 8.53 g/100g NaCl.

Figure 39 shows micrographs obtained for osmosed cube tissues immersed in 360 min at various osmotic solution concentration of (-1,-1), (0, 0) and (1, 1) code value. It was found that samples treated in higher solution concentration resulted in more shrinkage of the tissue than the sample treated in lower solution concentration. Due to when the plant cell is put in an osmotic solution, water will flow out of the cell until the turgor is lost and the plasmolyzed protoplast pulls away from the cell wall (Ferrando and Spiess, 2001). The more lost of turgor cell could be occurred when immersed in the higher concentration osmotic solution. The degree of compactness or collapse of cell structure increase with the concentration of the osmotic solution. Figure 39 c) shows sample micrographs after immersed in maximum time (360 min) and osmotic solution concentration (code value (+1, +1)). It can see a compact cell structure and more collapse due to the greater cellular dehydration and solid penetration of the tissue. However, the cells still remain their shape. At this point it can describe along with mass transfer behaviour that even treated the persimmon at the maximum immersion time and concentration osmotic solution which can reached *WR*, *WL*, and *SG* at 0.4885, 0.898 and 0.0013 kg/kg, respectively, the cell structure was not destroy too much and not lead to cell fracture. These results can imply that osmotic treatment is a gentle method of removing water from plant tissues.

2.2.4 Water Activity

Water activity values of persimmon decrease for all treatment during osmotic dehydration process. There were not significant differences at the end of osmotic process among treatments using osmotic solution contained 45.00 g/100g sucrose and 5.00 g/100g NaCl (code value 0, 0), and 55.6 g/100g sucrose and 8.53 g/100g NaCl (code value +1, +1) (Figure 40). However, it clearly seen that treatment using osmotic solution code value (0, 0) and code value (+l, +1) shows faster decay in water activity in the end of osmotic dehydration. All shape samples (disk, cube and whole fruit) could reach water activity values around 0.82-0.85 at the end of osmotic process when using osmotic solution code value of (0, 0) and (+1, +1). Concerning the rate of mass transfer, it can be observed that treatment performed at the higher concentration solution showed greater diffusion coefficients of water and solute which seems to be activate the behavior of water loss and capable of gain more solid. So that it can showed the fastest approach with lower water activity value.

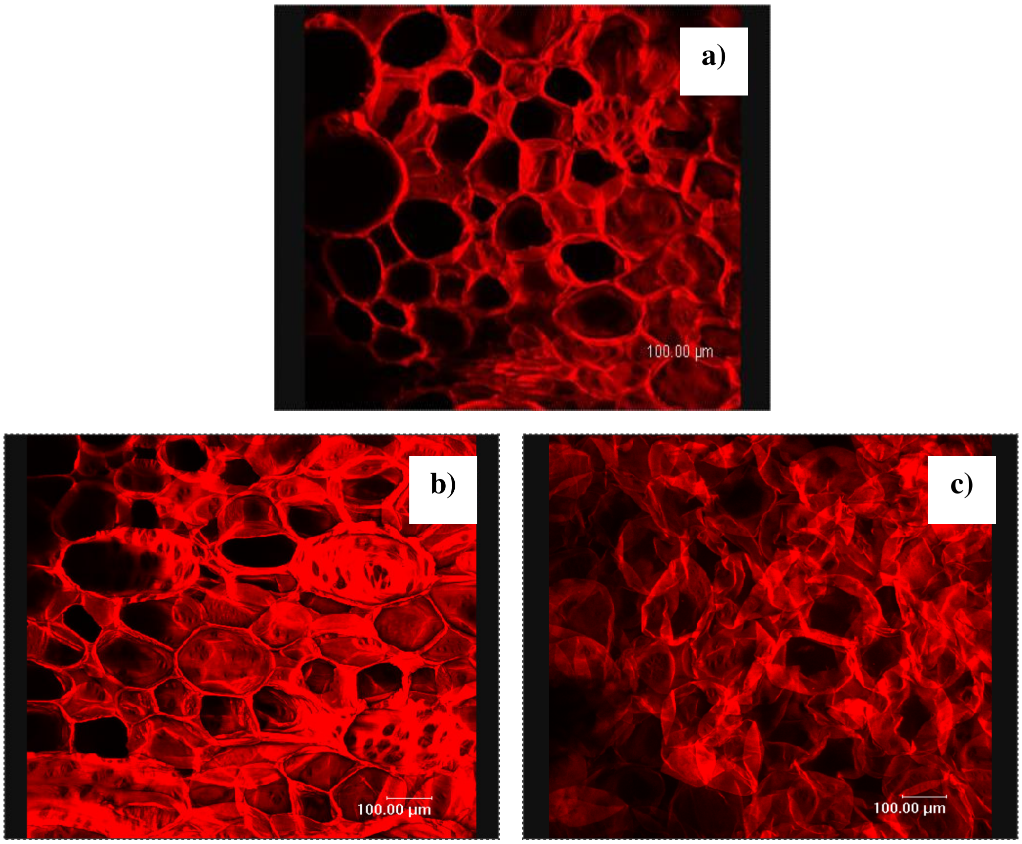


Figure 39 Confocal micrograph of the tissue of persimmon cube immersed in 360 min at different various osmotic solution contained a) 34.4 g/100g sucrose and 1.47 g/100g NaCl (code value -1,-1), b) 45.00 g/100g sucrose and 5.00 g/100g NaCl, and c) 55.6 g/100g sucrose and 8.53 g/100g NaCl (code value +1, + 1).

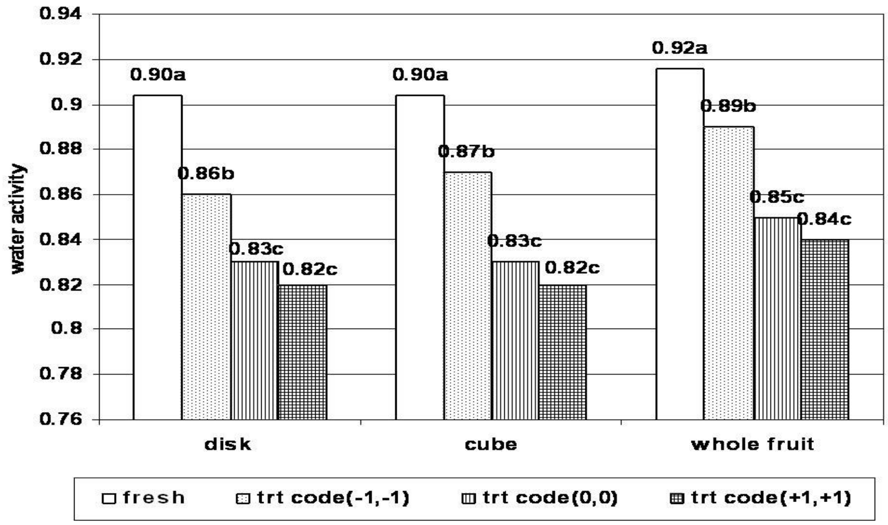


Figure 40 Water activity of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.

2.2.5 Sucrose and NaCl Content

Figure 41 shows the sucrose content of fresh and osmotically persimmon which quantified by HPLC. The sucrose exchanges during osmotic treatment modified the sucrose content distribution of the fresh persimmon. At the highest amount of sucrose in the osmotic solution, as expected, by far the greatest sucrose content remains in the fruit. Sucrose content in osmosed persimmon increase during soaking in the osmotic solution from around 5% to 8% for all shape persimmon. NaCl content was shown as total chloride using the direct tritration method with $AgNO_3$ (Figure 42). During the osmotic treatment with the mixture of sucrose and NaCl solution it seems that sucrose having larger molecules thus it could not diffuse easily through the cell membrane. NaCl can penetrate the cells easily due to its low molecular weight. It was found that the NaCl content in the osmotically sample increase with increasing the concentration of NaCl in the osmotic solution. There were statistically significant differences between NaCl content in the persimmon using different osmotic solution concentration.

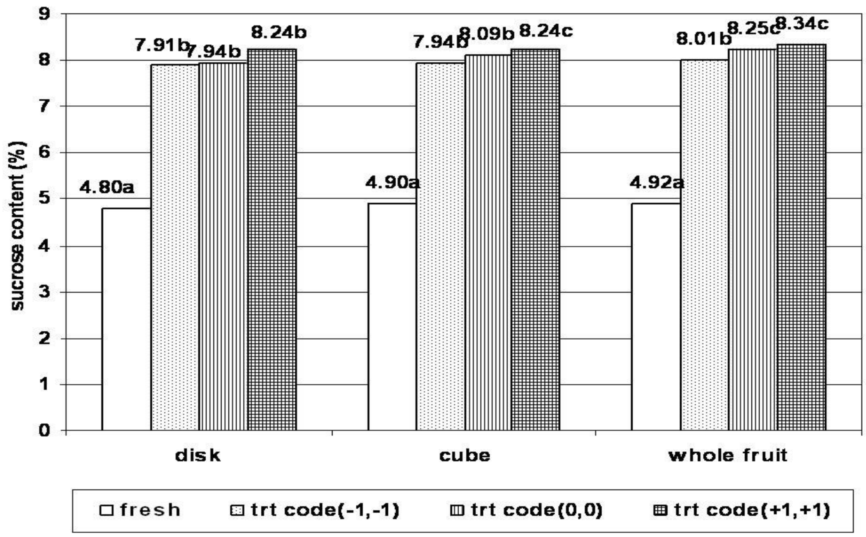


Figure 41 Sucrose content (%) of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.

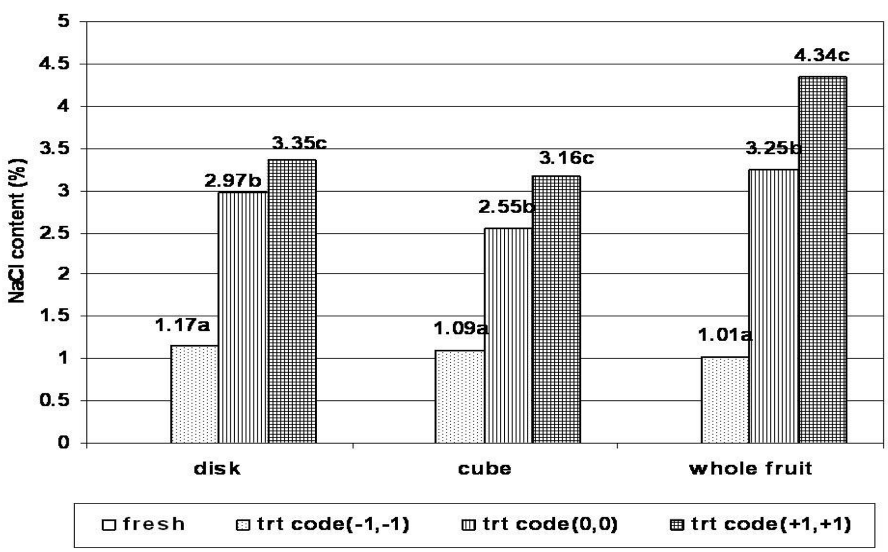


Figure 42 NaCl content (%) of fresh and osmotically persimmon by soaking in the osmotic solution of sucrose and NaCl in different concentration.

The product quality changes occurred after osmotic treatment of persimmon. The firmness texture of osmotically persimmon trend to soften compared to the fresh fruit. All osmosed samples had lower L* and relatively higher a* and b* compared to fresh samples. The increase in a* and b* was clean and seemed to be a resulted of solid uptake during osmosis treatment. The mass exchanges during osmotic treatment could reduce the water activity of product which benefit for preservation purpose. The osmosed product could reach water activity values around 0.82-0.85 at the end of osmotic process. The transfer of the sucrose and NaCl from the osmotic solution into the fruit occurred during osmotic treatment resulted in increasing in sucrose and NaCl content in the osmosed product. The maximum sucrose and NaCl content of the osmosed persimmon were up to 8% and 4%, respectively. From the microstructure observation, it was found that the osmosed cell changed their structure during osmotic process; however, it was not the severe changes.

These results agree with the others that all mass exchanges during osmotic process may have affect on the quality of dehydrated product (Sablani *et al.*, 2002; Singh *et al.*, 1999). However, osmotic process can use as a pre-treatment of many process to improves nutritional, sensorial, and functional properties of food without changing its integrity (Torreggiani, 1993). In addition, osmotic treatment has been improved shelf life stability with help of combined preservation methods (Raoult-Wack, 1994).