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Research Article

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The study of growth differences of infants less than 6 months which have used breast milk and infant formula along with breast milk

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ABSTRACT

Introduction: Infant growth during the first 6 months of their life is very important and critical to determine their health. There are many contradictions in various studies on the effect of breast milk or infant formula along with breast milk on the children growth. So, the current study is designed and implemented to determine differences among infants less than 6 months that use breast milk and infant formula along with the breast milk.

Methods: This study is a sectional- analytical study that has been conducted in Jahrom in 2013 on 269 infants between 0-6 months who were selected randomly. The data collecting tool was the questionnaire with its formal and content validity achieved by 5 professors. Also CVI:/76, CVR:/71 was calculated and its reliability for interviewers obtained /98 by Kappa coefficient on 20 cases. The information was analyzed by spss:16 software.

Results: The mean height, weight and head circumference of boys in both groups were more than girls. Using paired t-test showed significant differences between the two groups regarding the weight index in 3 and 6 month infants. But in the other indicators (in repeated measures) there was no statistically significant difference (p> 0.05).

Conclusion: The findings of this study emphasize the effectiveness of breastfeeding and suggest that to have healthy generation with efficiency and the ability in future, breastfeeding in the first 6 months of life is recommended.

Keywords: *growth, infant, breast milk, infant formula*

INTRODUCTION

Growth is a dynamic process and deviation from the determined national benchmarks is an important indicator to recognize the incidence of medical disorders. The rapid growth of children during the first 6 months of their life makes specific nutritional needs, so the required energy for infants is 3 times more than an adult (1). Disruption in supplying these needs can cause disorder in growth and its quantitative indicators, as well as the evolution of various organs of child body (2.(

Undernourishment and in other words, deviation from normal growth percentiles starts from these ages. Growth monitoring means the measurement of height-weight- head circumference and is also the most important indicator to understand the nutritional adequacy of children. So, when the calorie intake is insufficient, first the weight , then the height and head circumference percentiles are reduced. If this measurement is taken frequently and regularly it can determine the nutritional adequacy of a baby (3).

Most appropriate and most natural nutrition for children is breast milk, because it provides the most physical and emotional relationship for mother and child. On the other hand it can vaccinate children against many diseases.

Numerous studies have shown that children who are breastfed have a lower incidence of hospitalization, gastrointestinal infections, diarrhea, allergies and other diseases. Because at least there are 100 materials in breast milk that are not found in infant formula (4).

Several studies worldwide have shown that despite widespread publicity about breast milk, it is also used as an alternative for infant formula or breast milk additives for various reasons. Although modern infant formula can somewhat replace breast milk, but still can't replace it metabolically and emotionally (5).

According to the study of Kramer et al., the earlier an infant is weaned, the sooner infant formula starts for him and he will have faster growth (6). Nilsson et al. showed that infants between 5-10 months that have only used breast milk for 7 months, have lesser height and weight compared to the group that have used breast milk lesser than 7 months (7,8). Ong et al. emphasize that the study of breast milk alone can't retain the increasing trend of children growth (9, 10). Some sources suggest that the use of breast milk in the first months cause growth increase but replacement with infant formula cause height and weight increase while has no effect on the child's head circumference (11). Infants who have used breast milk along with infant formula had more increase in height and weight than the children who had only been breastfed. Therefore it can be concluded that the evidence shows that breast milk replacement with infant formula can quickly improve the child growth, while reliable sources and other studies negate such expressions. Since the base of child growth and development is his feeding, therefore, due to inconsistencies in child feeding manner, this study examines the feeding and nutrition manner. This study aimed to determine the differences in height, weight and head circumference of infants less than 6 months that only used breast milk or breast milk along with infant formula.

MATERIALS AND METHODS

Methods: This study is a sectional- analytical study that has been conducted in Jahrom in 2013 on 269 infants between 0-6 months. All infants born in October-December (chosen randomly) 2013 were enrolled from all health centers. Inclusion criteria were: complete health records, being full term, mother and baby should not have experienced obstetric complications, their vaccination is full, and pediatrician has confirmed the child health. All the health records of children were extracted at the time of birth and their 1, 3 and 6 months. The data collecting tool was the questionnaire that its formal and content validity was achieved by 5 professors. Also CVI:/76, CVR:/71 was calculated and its reliability for interviewers obtained /98 by Kappa coefficient on 20 cases. 3 questioners received the necessary training and the data collection began under the supervision of executives. Gram and centimeter scales were used as international standard for reporting. All software spss: 16 were analyzed. The information was analyzed by spss:16 software.

Fingings: Of total 269 children, 139 were boys and 130 were girls (Table 1), in both groups average height, weight and head circumference of boys were more than girls (Table 2 and 3). With the Chi-square and Spearman test no significant relationship was found between maternal and paternal age, education, income level and number of children and the number of successful pregnancies, with the measured parameters in the expressed periods (P> 0.05). With the help of paired t-test, significant differences were observed between the two groups regarding weight at 3 and 6 months (Table 4).

Table 1: Absolute frequency of infants according to their sex and feeding type

	Breast milk	Breast milk and infant formula	Total	K2
Boy	116	23	139	P=0.65
Girl	109	21	130	
Total	225	44	269	

Table 2: Mean and standard deviation of infants' growth indices who are just breastfed

		Boy	Girl	Total
Weight	Birth time	3618.2±557.95	3570.23±500.41	3594.21±529.68
	month 1	4277±580.15	4510.7±647.94	4393.85±614.04
	months 3	6384.89±690.26	5824.51±671.39	6104.7±680.82
	months 6	7823.52±894.58	7145.58±748.4	7484.55±821.49
Height	Birth time	50.05±2.44	49.61±2.54	49.83±2.49
	month 1	54±3.59	53.49±2.92	53.74±3.25
	months 3	60.77±3.46	59.49±3.37	60.13±3.41
	months 6	67.55±2.65	65.61±3.81	66.58±3.23
Head circumference	Birth time	35.84±1.82	35.45±1.44	35.64±1.63
	month 1	37.41±1.75	37.03±1.33	37.22±1.54
	months 3	40.13±1.38	39.23±1.33	39.68±1.35
	months 6	43.51±2.47	42.19±1.34	42.85±1.90

Table 3: Mean and standard deviation of infants' growth indices who are breastfed along with infant formula

		Boy	Girl	Total
Weight	Birth time	3547.05±799.89	3338.46±461.04	3442.75±630.46
	month 1	4427.27±686.03	4215.62±792.4	4321.44±739.21
	months 3	5874.72±754.58	5497. 5±577.07	5686.11±665.82
	months 6	7452.38±666.79	6921.05±657.93	7186.71±662.36
Height	Birth time	49.7±4.32	49.69±2.65	49.69±3.48
	month 1	53.47±2.77	52.84±2.47	52.97±2.62
	months 3	59.04±3.55	58.07±3.32	58.55±3.43
	months 6	66.56±2.45	66.13±3.94	66.34±3.19
Head circumference	Birth time	37.2±1.59	35.34±.987	36.27±1.28
	month 1	38.25±1.59	36.87±.903	37.56±1.24
	months 3	39.79±1.72	38.95±.856	39.46±1.28
	months 6	42.8±1. 7	42.04±.85	42.42±1.27

Table 4: Mean and standard deviation of the overall infants' growth indices

		Breast milk	Infant formula+ Breast milk	Paired T-Test P value
Weight	Birth time	3594.21±529.68	3442.75±630.46	0.54
	month 1	4393.85±614.04	4321.44±739.21	0.77
	months 3	6104.7±680.82	5686.11±665.82	0.04*
	months 6	7484.55±821.49	7186.71±662.36	0.02*
Height	Birth time	49.83±2.49	49.69±3.48	0.88
	month 1	53.74±3.25	52.97±2.62	0.13
	months 3	60.13±3.41	58.55±3.43	0.045
	months 6	66.58±3.23	66.34±3.19	0.91
Head circumference	Birth time	35.64±1.63	36.27±1.28	0.15
	month 1	37.22±1.54	37.56±1.24	0.93
	months 3	39.68±1.35	39.46±1.28	0.92
	months 6	42.85±1.90	42.42±1.27	0.93

Discussion:

According to the average height and weight of children at birth, 1, 3 and 6 months compared with standard growth curve, it can be stated that in both groups measured indices were between 50-75% percentiles (lying in the natural area) and there was no deviation during that time in any of the cases. Although in both groups the measured growth indicators of girls are less than boys. According to multiple sources and considering gender and genetic features, this seems to be natural (13).

The mean head circumference at birth, 1, 3 and 6 months of age compared with standard growth curve, it can be stated that in both groups measured indices were between 25-50% percentiles (lying in the natural area) and there was no deviation during that time in any of the cases. But in terms of weight and height it was in lower percentiles. According to the above data it is concluded that both boys and girls are within the natural areas of growth which can be a sign of proper care during pregnancy and breast-feeding as well (14).

In both groups and in all time periods, the average of measured indices of boys was higher than those of girls and this difference was observed from birth until the age of 6 months. Except for those who were only breastfed, the weight of 1-month girls was more than boys and this weight increase (7/233 g) seemed evident.

During comparing the average weight of two groups, it became clear that although there is no significant difference between these two groups at birth, but this difference is statistically significant at 3 and 6 months ($P < 0.05$). There is no such a significant difference in average height, but for the average index of head circumference, infants who had used both milk, had higher averages at birth time, and the only use of breast milk could obviate this difference, although this difference was not significant statistically.

According to the above-mentioned issues, it seems that the use of breast milk from birth to 6 months is adequate for the child's growth. This point is emphasized in the study of Nielsen et al. (7, 15-18). Therefore, family education to promote breastfeeding can affect physical and emotional health for mother and child. This point is emphasized and confirmed by World Health Organization (19, 20). The limitations of this study are incomplete documents of some research samples which were excluded from the study and small population of the study.

Conclusion: The findings of this study emphasize the effectiveness of breastfeeding alone and suggest breastfeeding in the first 6 months of life to have a healthy generation with enough efficiency and ability. It is recommended that children with growth disorder that use breast milk and infant formula be examined in a larger population.

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Materials and Methods

Isolate of soya protecin with Amisoy was purchased from Netherland Elmeray Company. Aloe Vera: It was purchased from Kimya Khorasan.

2.1.Preparation

This fruit (Avocado)was provided from local market from Tehran of one variety. To reduce respiratory and biological activities to testing time in refrigerator, it was kept at temperature 4 $^{\circ}C$. At the beginning of test, Avocado was washed and peeled, then by nicer dicer made in Germany was divided into circular slices with thickness 10mm. Avocado slices and their thickness were controlled with caliper with precision 0.02 mm.

2.2.Coating

To coat product before osmotic dehydration, Whey soya protein with level 5% was used. For coating process, avocado slices were submerged for 60s in coating 0.05. After coating of Whey, the specimen was put for 2min on filter paper to eliminate extra gel. Finally to fix coating, the specimen was put in hot air oven for 15min at temperature 70 $^{\circ}C$ (6).

2.3.Osmotic and ultrasound dehydration

In this study, Aloe Vera syrup was used as osmotic medium. Aloe Vera concentration was selected 35%, 55%. The dehydration process temperature during the process and in all treatments was constant and equal to ambient temperature (25 $^{\circ}C$). The ratio of Avocado to osmotic medium was 1 to 4 (19). The tests were performed by applying dynamic conditions (agitation of osmotic solution) during once per hour (27). After coating and coating fixation, slices were under ultrasound (25 kHz) for 30min and 180 min osmotic (without ultrasound). After dehydration process, avocado slices were taken out of osmotic medium and they were washed with deionized distilled water and were put on filter paper (Wattman) to absorb water and for additional drying, they were put in hot air dryer equipped with air fan at fixed temperature 70 $^{\circ}C$ (31).

2.4.Qualitative test

2.4.1.PH

Also, PH was measured by digital pH meter (3510 model, Jenway company) (13).

2.4.2.Shrinkage

To measure Shrinkage, the specimens were dried at required temperature and then Shrinkage was determined by the following equation (32).

$$\%SKG = \frac{V_{\circ} - V}{V_{\circ}}$$

In this equation, Vo is fresh avocado slice (cm3) and V is volume of avocado slice and after drying (cm3). The samples volume was computed by toluene displacement method.

2.4.3.Rehydration

The specimen rehydration was computed via calculation of increase of weight of sample after 3 hours of submerging in distilled water at ambient temperature compared to dried weight before submerging at ambient temperature (21).

2.4.4.Sensory evaluation

Sensory evaluation test was performed by a group of sensory analyzer composed of 5 food industry experts. All evaluations were performed by product-oriented sensory test (scoring method of severity of a property) with 5-point hedonic scoring. Some questionnaires were provide and 5 questions were asked of each person and 5 choices were used for the responses. The questions were color, flavor, taste, aroma, touch and total acceptance. It is worth to mention that age group of analyzers as men and women were 25-50 years old (34).

3.Data analysis method

This test was factorial test in fully randomized design with 3 replications. The comparison of mean of Tukey HSD was performed by Dunckan test at 5% level and to perform variance analysis, SAS software, version 9.1 was used and chart was ploted with Excel 2007.

Results and Discussion

4.1.PH

Based on the effect of time and concentration type of dehydration medium during osmotic and ultrasound dehydration on PH of Avocado, the highest amount was observed in solution 35% and ultrasound for 30min (Chart 1). The results showed that the mutual effect of time and concentration of dehydration medium under ultrasound and osmotic medium was significant at level 5%. Sugar and acidic materials (ascetic acid) were absorbed from osmotic medium to fruit texture and increased acidity and reduced PH. By increasing drying time of specimen, 55% at temperature 70 $^{\circ}C$, due to level hardening and increase of sugar in Avocado to organic acids (ascetic acid) increased acidity and reduced PH in specimen 55% compared to specimen 35% (5). Absorbed organic acids from osmotic solution can reduce PH of production and phenolase enzyme activity and browning is reduced (1, 6, 13). As drying time of specimen under dehydration with ultrasound was lowered due to cavitation compared to osmotic dehydration, the specimen were less exposed to hot air oven. Thus, less amount of sugar was remained in Avocado and were converted to organic acids in ultrasound and acidity was reduced in ultrasound and increased PH (5). Eshraghi et al., (2011) evaluated the effect of ultrasound on drying Kiwi slices and stated that by increase of ultrasound time, humidity time 20% was reduced. Also, drying time was reduced and the specimen were dried at short time. Radmard Ghadiri (2011) by various temperatures during dried plum showed that the increase of PH led into the increase of temperature and drying time.

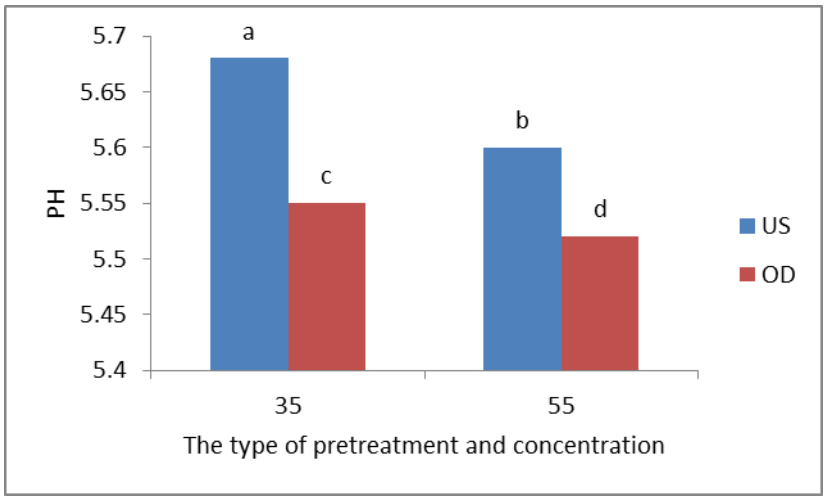

Figure 1. The effect of time and dehydration medium on PH of Avocado during dehydration process

Based on the effect of coating on PH in avocado, the highest PH value was observed in non-coating specimen with significant difference at level P<0.05(Chart 2).

As drying time of coated samples were less than non-coating samples, dehydration was higher in

coated samples compared to non-coating samples and food coating increased osmotic dehydration efficiency (Jalayi et al.,). The increase of drying time in non-coating specimen caused that samples were exposed to hot air of oven at much time (Seraji et al.,). Thus, high amount of sugar in Avocado was converted to organic acids and acidity was reduced and PH was increased and this increased the sugar of sample to organic acids and increased acidity and reduced PH (9). Tavakolipour et al., during Rheum drying found that by increase of temperature, sugar in fruit was converted into organic acids and acidity was increased and PH was reduced.

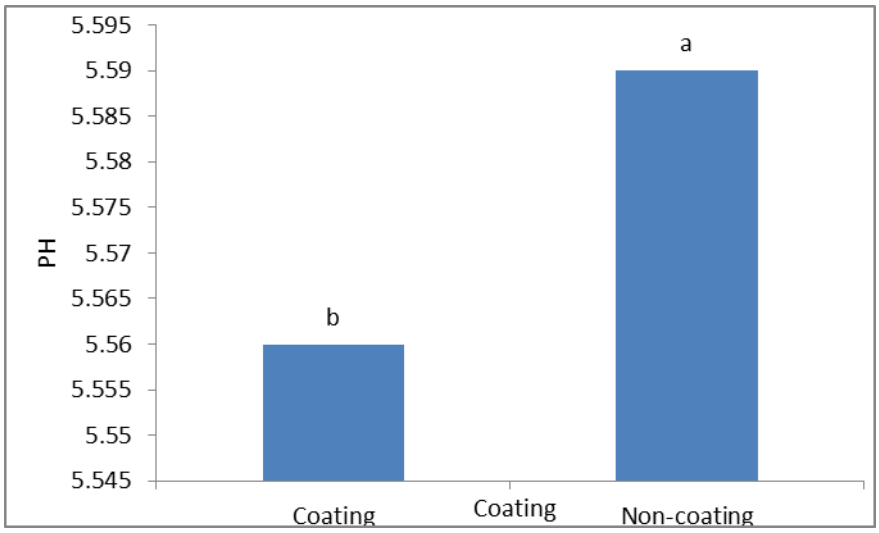

Figure 2. The effect of coating of osmotic dehydration medium on PH of avocado

4.2.Shrinkage

Based on the effect of medium type and using ultrasound pre-treatment on Shrinkage in Avocado, the lowest Shrinkage in ultrasound 30min in solution 55% was observed (Chart 3)

Under ultrasound pre-treatment, less Shrinkage is observed compared to osmotic specimen and in osmotic media, less Shrinkage was observed in solution 55% compared to 35% solution. By the increase of concentration, solid absorption was increased and Shrinkage was reduced. Due to long osmotic dehydration time (180min) and level hardening at high concentrations, less Shrinkage was observed at concentrations 55% of osmotic solutions compared to concentrations 35%. Shahidi et al., (2011) evaluated the effect of osmotic and ultrasound pre-treatment on some properties of dried banana by hot air method and stated that by increase of concentration, solid absorption percent was increased and Shrinkage was reduced. High concentrations and long dehydration time created a hard crystal layer on surface. This state during drying created hardening and avoided Shrinkage.

Ultrasound pre-treatment and cavitation reduced connection of water molecules to food and the specimen was dried at short time and Shrinkage was reduced (4).

Jambrak et al., (2007) evaluated the effect of ultrasound on mass transfer and rehydration in drying button mushrooms, Brussels cauliflower sprouts and the results showed that in pre-treatment samples with ultrasound, mass transfer was increased and hot air drying time was reduced and re-absorption of water was increased and Shrinkage and texture damage were less. Schossler et al., (2012) showed that ultrasound pre-treatment reduced drying time due to the increase of effective diffusion of humidity. In addition, ultrasound reduced Shrinkage and increased volume ratio compared to control treatment.

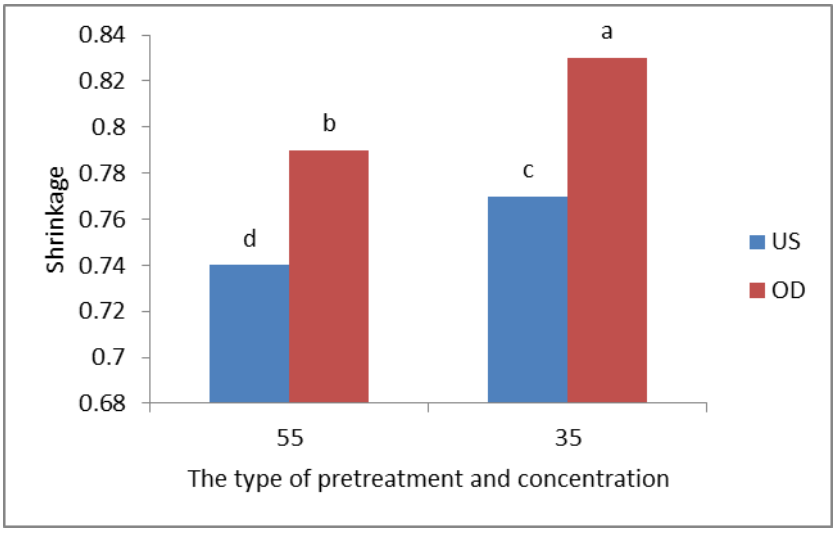

Figure 3. The effect of time and dehydration medium on Shrinkage of Avocado during dehydration process

Based on the effect of coating on Shrinkage in Avocado, the highest Shrinkage was observed in non-coating specimen with significant difference at level $P<0.05$ (Chart 4). By increase of drying time in non-coating specimen compared to coating samples, reduced connection of water molecules to food and sample was dried at short time and Shrinkage was reduced (4). Based on the effect of coating on Shrinkage in Avocado, the highest PH was observed in non-coating samples and lowest value in non-coating samples with significant difference at level $P<0.05$.

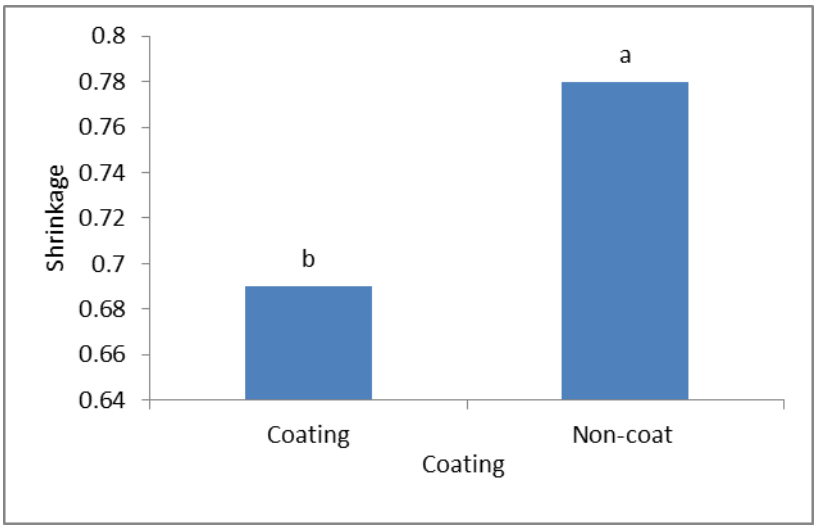

Figure 4. The effect of coating on Shrinkage of Avocado during osmotic dehydratio**4.3.Re-hydration**

Based on the effect of time, type and concentration of dehydration medium during osmotic dehydration and ultrasound on re-hydration in Avocado, the highest rehydration wasobserved at ultrasound 30min in solution 35% with significant difference at level P<0.05. Less re-hydration was observed in osmotic state compared to ultrasound due to solid absorption in osmotic process and this was effective on cells permeability and re-hydration was reduced (9). The results of studies of Bakalis and Caradonoze (2005), Rastogi et al., (2004), Leoyiki (1998) and Fakhri Shahidi et al., (2011) showed that osmotic dehydration process had negative effect on re-hydration and the reason was rapid saturation of lower layer of food texture with sugar and less hydration of sugar layer compared to natural texture of food. The osmotic solution concentration was effective on re-hydration as by increase of osmotic solution concentration due to high solid absorption, rehydration of samples was reduced (9). Ultrasound waves increased re-hydration compared to osmotic (without ultrasound) due to microscopic channels of cavitation and sponge effect. Dried samples with ultrasound had porous texture compared to dried sample by osmotic solution (without ultrasound) and control sample and it absorbed water better (4). Eshraghi et al., (2011) evaluated the effect of ultrasound on drying Kiwi slices and stated that the increase of ultrasound time increased rehydration of dried kiwi samples compared to control sample. As ultrasound waves can create sponge state in product, it can absorb water easily and it can achieve maximum water absorption. Jambrak et al., (2006) applied ultrasound waves for rapid drying of button mushrooms, Brussels sprouts and cauliflower. By the increase of ultrasound time, due to creating high microscopic channels, based on cavitation, the sample has highly porous texture compared to control sample and also it has good water absorption. The increase of re-hydration in control sample was less in ultrasound waves compared to dried sample (Chart 10). They are consistent with the results of Jambark et al., (2006). Ashraghi et al., (2011) evaluated drying Kiwi slices with ultrasound and stated that by increase of ultrasound time, due to high microscopic channels, due to cavitation and sponge effect, the dried Kiwi sample had highly porous texture compared to control sample and it had good water absorption compared to control sample. Cavitation had considerable role in separation of water connected to food. The required time for drying was reduced and Shrinkage was reduced and re-hydration was also increased. The results of Jambark et al., (2006) and Blanko et al., (2006) and Dolavtuski (2007) regarding drying time showed that increase of rehydration in control sample was higher than dried samples at osmotic state (without ultrasound). Based on the negative effect of osmotic process on rehydration and rapid saturation of lower layer of food texture with sugar and less dehydration of sugar layer compared to natural texture of food is justified (9).

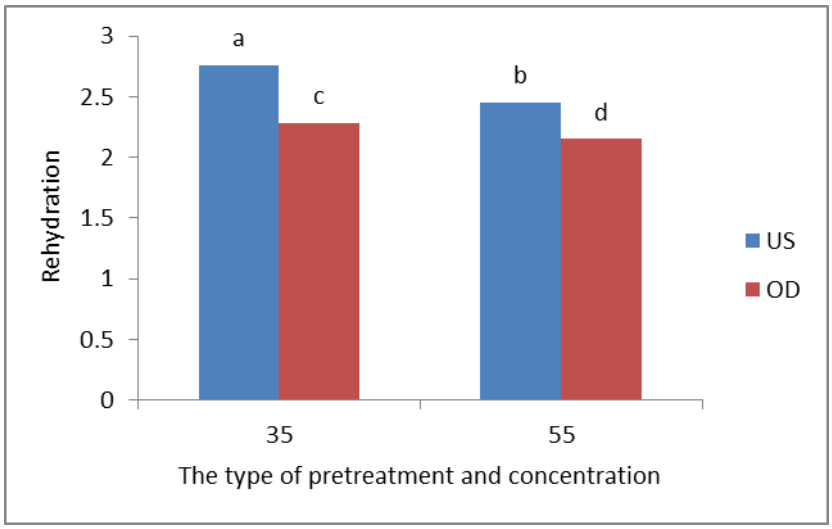

Figure 5. The effect of time and dehydration medium on rehydration of Avocado during dehydration process

The results of variance analysis of rehydration of Avocado during osmotic dehydration showed that the effect of coating at statistical level 5% was significant on Avocado rehydration property ($P<0.05$). Low rehydration in coating samples compared to non-coating due to solid absorption in osmotic process and this was effective on permeability of cells and rehydration was reduced by samples (9). The maximum increase of solid absorption in non-coating was observed. Absorption of dissolved solid in coating samples was less than non-coating samples. The results showed that materials coating before osmotic dehydration prevented the influence of solid materials of solution to food texture and had no negative effect on water exist (6).

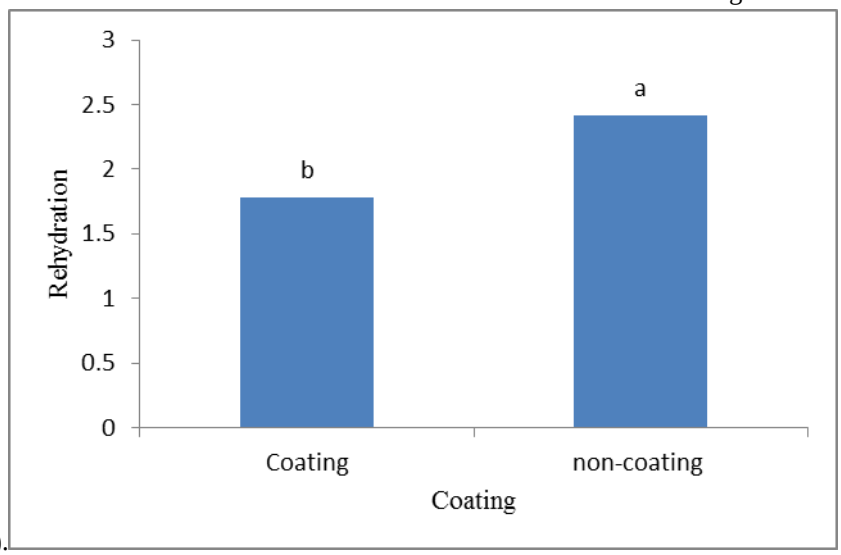

Figure 6. The effect of coating on rehydration of Avocado during osmotic dehydration process

4.4.Sensory properties of dried Avocado

To evaluate organoleptic properties of dried samples, 4 sensory properties including color, texture, flavor and tastes and total acceptance were evaluated (Table 1).The results of various researchers regarding the effect of osmotic pre-treatment on aromatic maintenance showed that due to osmotic process in environment without oxygen and heat increased the durability of aroma and flavor of product and also increased its fresh property (24). Using coating besides osmotic process control reduced loss of nutrients and organoleptic properties as coating avoided humidity loss. During fruit dryness, humidity is lost and chewing dry fruit is hard and coating makes the fruit soft and

chewing can be easier. Also, aroma and flavor of fruit are kept and also the fruit can be kept for a long time. This coating creates shining coat on fruit and fruit stickiness is avoided. Coating dried parts avoids much aroma and flavor (15). In terms of chewing, the results show that osmotic samples had high rank compared to other products. This issue is regarding crystal structure compared to chewing of texture and this issue is considered well by analyzers. The higher the humidity, the lower the brittleness . Regarding the color, the color of treated samples by osmotic dehydration method had high acceptance compared to ultrasound dehydration. In osmotic

dehydration, due to the increase of dryness of sample and hardening and increase of converting sugar in Avocado to organic acids (Ascetic acid) reduced phenolase enzyme activity and browning (1, 6, 11).

Table 1: The sensory evaluation results of dried Avocado

Total acceptance	Texture	flavor and taste color	coating	osmotic process	concentration of osmotic solution	
$3/7^{e}$	$4/2^{b}$	$3/7^{d}$	$3/1^{f}$	-	Osmotic	55
$3/5^{g}$	3^{f}	$3/5^{e}$	$3/4^{e}$	-	Ultrasound	55
$4/2^{c}$	$4/6^{a}$	$4/6^{a}$	$3/7^{d}$	+	Osmotic	55
$4/7^{a}$	4^{c}	$4/2^{b}$	$4/5^{b}$	+	Ultrasound	55
$3/9^{d}$	$3/2^{e}$	$3/1^{f}$	$3/38^{e}$	-	Osmotic	35
$3/1^{h}$	$3/2^{e}$	$2/7^{g}$	$3/7^{d}$	-	Ultrasound	35
$4/4^{b}$	$4/6^{a}$	$4/2^{b}$	$4/2^{c}$	+	Osmotic	35
$3/9^{d}$	$3/7^{d}$	4^{c}	$4/9^{a}$	+	Ultrasound	35
$2/9^{h}$	$2/27^{g}$	$2/3^{h}$	$2/7^{g}$			Control

Conclusion

By various pre-treatments, we can reduce disadvantages of drying process and turn it into a technology with high value added with better physicochemical properties compared to conventional samples. In this study, after pre-treatment of coating, osmotic and ultrasound, the samples were dried in hot air oven and Shrinkage, rehydration and PH and sensory evaluation were evaluated. The results showed that ultrasound compared to osmotic dehydration caused that using acidity ultrasound reduced Shrinkage in fruit significantly and increased PH and rehydration. Sensory evaluation of color, aroma, flavor, texture and total acceptance between coating and non-coating samples showed that non-coating samples had high acceptance compared to coating samples and control samples. Finally, we can say coating of Avocado samples with isolate of Soya protein and by ultrasound dehydration process based on reduction of drying time and creating high quality product could be a good pre-treatment to increase quality of avocados dried by conventional method.

References