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Influence study of (Vitamin C) absorption on the mechanical properties of (Poly ethylene terphthalate) drinking bottles

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ABSTRACT

In this research, the study shows the effect of vitamin C absorption by poly ethylene terphthalate (PET) bottles on mechanical properties of (PET) bottles that was investigated through tensile test. The polyethylene terphthalate bottle containing orange drinks with (50ppm) initial concentration of vitamin C were stored for about three months at (10, 25 , 50 ºC) and the mechanical properties (tensile strength , modulus of elasticity and elongation) of poly ethylene terphthalate bottles were measured periodly during the storage time . The effect of vitamin C on the mechanical properties of (PET) bottles was compared between of the (PET) bottles containing orange drinks with (50ppm) vitamin C and the (PET) bottles containing orange drink without concentration additional of vitamin C solution , maximum effect of vitamin C on mechanical properties of (PET) bottles was observed on the samples stored at 50ºC that could be represents to the high amount of absorbed vitamin C at high storage temperatures . It was also found that tensile strength and modulus of elasticity of (PET) bottles decreased with the absorption degree of vitamin C, while the elongation increased..

Introduction

Polyethylene terphthalate (PET) is acoplymer of ethylene glycol with either terphthalic acid or di – methyl terphthalte (1). It is commonly used as packaging material for drinking water, mineral water …etc :(2). As polymer packaging is more and more widely used for direct contact with foods (3), product compatibility with the packaging material must be considered(4). Absorption of flavours causes the aroma or changes in mechanical properties of polymers (5). On the other hand, the entrance of undesirable odurs, in to the food from the external environment through the plastic constitutes a variation on flavour scalping (6), plastic packaging materials are not active in allowing mass transfer of compounds such as, water, gases flavours and monomers in food(7).

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Beltran Gonzalez investigated the effect of different packaging materials on the shelf life of the juice in transparent (PET) was much shorter than in packed carton (8) . In similar study shows (Berlinet) the colour and surveyed the effect of palm oil fatty acid on the mechanical properties of (CaCO3) filled natural rubber compounds(9). There is little information reported on the effect of interaction between foods and packaging material on mechanical properties of the materials. In the another study hand (Taufik etal) used titration method to absorption of apple drink packed in (PET) bottles (10).

Materials & Methods:

Vitamin C (ascorbic acid) was purchased from (Fluka Company), orange drink samples which were used as model solutions during the tests were propuced by (Golden Pan) company in Thailand. PET bottles (0.5 liters as volume) were used as packaging materials, for and studying the effect of vitamin C absorption on mechanical properties of (PET) bottles containing orange drink (50ppm) added from vitamin C designated as" A group " with (PET)bottles containing orange drink with adding (50ppm) vitamin C (blank solution) and designated as (B group). Absorption studies were performed on "A group " samples. The samples stored at (10ºC, 25ºC and 50ºC) and for periods (90 days) they tested at different periods. The (PET) bottles was cut into small pieces after the solution was removed and the plastic spices after the solution was removed and the plastic pieces were rinsed with distilled water after solution removal . One gm of surface bottle was placed in 10 gm of chloroform solvent and rested for (24hrs) to complete the extraction of vitamin C from (PET) bottles , and the absorption ratios for vitamin C in (PET)bottles were calculated and tested mechanical properties as tensile strength, modulus of elasticity and of elongation were measured by Instron instrument model (6025) with across head speed of (10mm / min). The procedure used was adopted from (ASTM) standards D882(2002). The specimens were tested to obtain an average value

Results and discussion

Absorption of flavour compounds into packaging materials may result in products with an in balance of flavour and aroma. in the present study the results showed that the absorption of vitamin C in (PET) bottles is a function of storage time and different temperature from fig (1) observed that slower rate of absorption of vitamin C at low temperature this inferred that the diffusion process is temperature – dependent . Our results showed that for all the samples stored at different temperature conditions after about (20 days) the slope of absorption curve suddenly decreased and the samples reached an equilibrium point (saturated point) . This phenomenon may cause a decrease of (vitamin C) absorption into (PET)bottles , and observed that the absorption ratio be higher in (50ºC) and smaller in (25 ºC) , because of the lower mount of (vitamin C) absorption into (PET)bottles . Tables (1) , (2) and (3) show the mechanical tests, tensile strength , young modulus and elongation ratio of (PET) bottles for both (A) and (B) group . The results also showed an increasing (vitamin C) absorption into (PET) bottles at higher temperatures and the difference between the mechanical tests of both group of (A) and (B) bottles . At 50ºC , because of the lower amount of vitamin C absorption in (PET) bottles , the mechanical tests of (PET) material did not change significantly. More absorption increasment of vitamin C at higher temperature severly reduced the tensile strength and modulus of elasticity of (PET) bottles while the elongation increased. Generally observed from all results in tables and figures that tensile strength and modulus of elasticity of the(PET) bottles were increased during contact with orange drink , higher temperatures in results , tables (1), (2) and (3) showed that tensile strength and modulus of elasticity decreased with increasing for the vitamin C absorption in (PET) bottles, especially at higher temperatures. The reduction in modulus results in an increase of polymer rubbery behaviour compared to it glassy state. Decreasing trends in tensile strength and young modulus and increasing in elongation which were observed in both groups of bottles (A and B) and this due to the related plasticization effect which exist in orange drink.

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Table (1) Show change in tensile strength (MPa) of PET bottle to orange drink containing 50 ppm (A) and blank bottles (B) .

Time (day)	10°C		25°C		50°C	
	A	B	A	B	A	B
0	70.00	70.00	70.00	70.00	70.00	70.00
15	62.80	63.00	66.20	62.50	62.80	64.30
30	55.70	56.30	64.30	57.70	58.70	61.40
50	53.50	53.90	59.90	52.50	52.40	53.40
60	50.60	52.70	56.00	51.40	51.00	52.50
70	48.10	50.40	53.00	50.60	47.80	50.00
90	44.80	43.50	52.80	48.80	46.90	48.50

Table (2) Show changes in young modulus (MPa) of PET bottles exposed to orange drink containing (50 ppm) vitamin C (A) and blank bottles (B)

Time (day)	10°C		25°C		50°C	
	A	B	A	B	A	B
0	980.00	980.00	980.00	980.00	980.00	980.00
15	940.00	960.50	877.50	906.8	896.00	926.00
30	920.00	955.50	685.70	750.70	724.00	828.40
50	840.20	820.00	637.10	636.60	618.30	778.50
60	775.50	766.00	608.50	604.60	615.50	679.70
70	715.20	705.40	580.90	575.00	605.50	660.30
90	700.80	685.50	556.40	548.50	588.40	610.50

Table (3) show changes in elongation percentage of PET bottles exposed to orange drink containing (50 ppm) vitamin C (A) and blank bottles (B) .

Time (day)	10°C		25°C		50°C	
	A	B	A	B	A	B
0	89.0	89.0	89.0	89.0	89.0	89.0
15	88.8	88.9	95.4	98.4	99.0	94.8
30	88.5	89.2	106.4	105.5	106.0	98.2
50	91.2	91.5	106.7	105.3	114.0	108.0
60	100.3	101.4	108.4	110.2	119.3	112.5
70	105.5	106.3	112.3	115.4	119.9	110.4
90	98.9	102.4	117.5	115.0	119.6	108.4

Table (4) show absorption percentage for orange drink into (PET) bottles during 90 days of storage at different temperatures.

Time(day)	10°C	25°C	50°C
0	1.10	3.02	4.23
10	5.33	8.42	12.00
20	8.24	13.00	20.44
50	10.00	15.00	26.00
90	10.00	15.00	26.00

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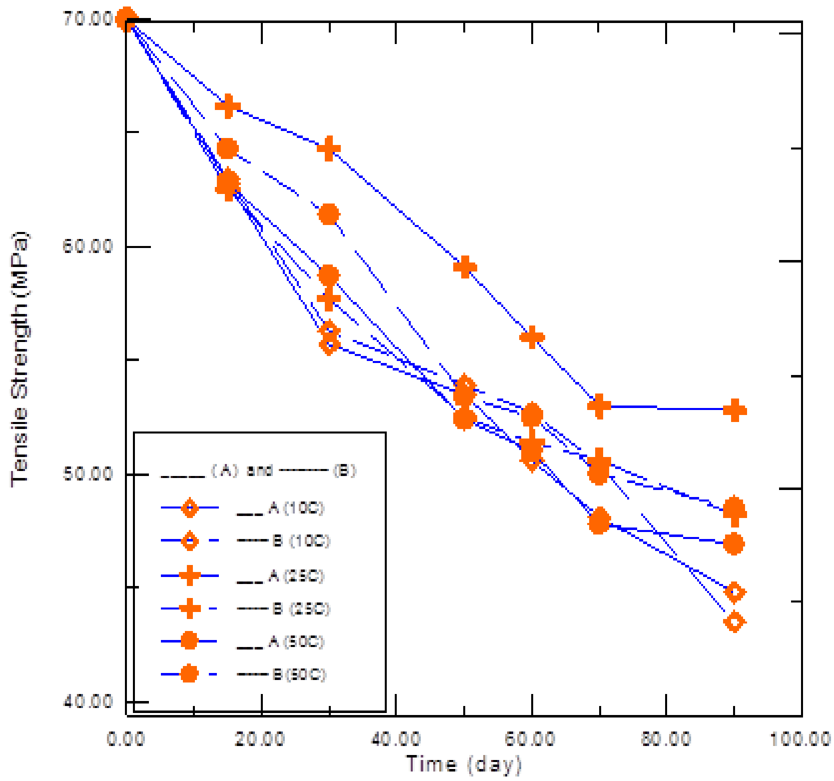

Fig (1) Show change in tensile strength (MPa) of PET bottle containing orange drink containing (50ppm) at different interval times.

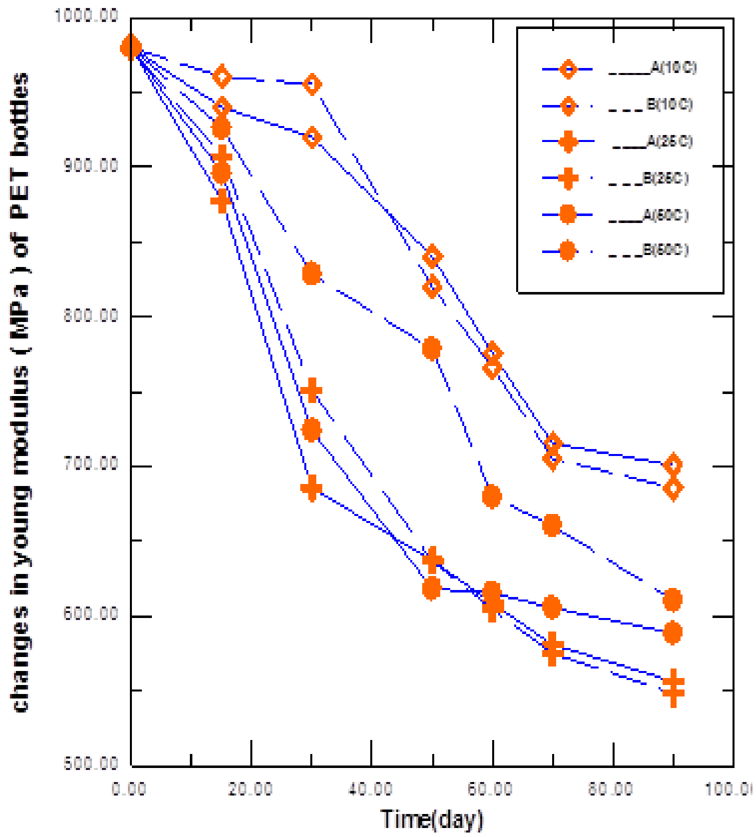

Fig (2) Show change in young modulus (MPa) of PET bottle containing orange drink (50 ppm) at different interval times.

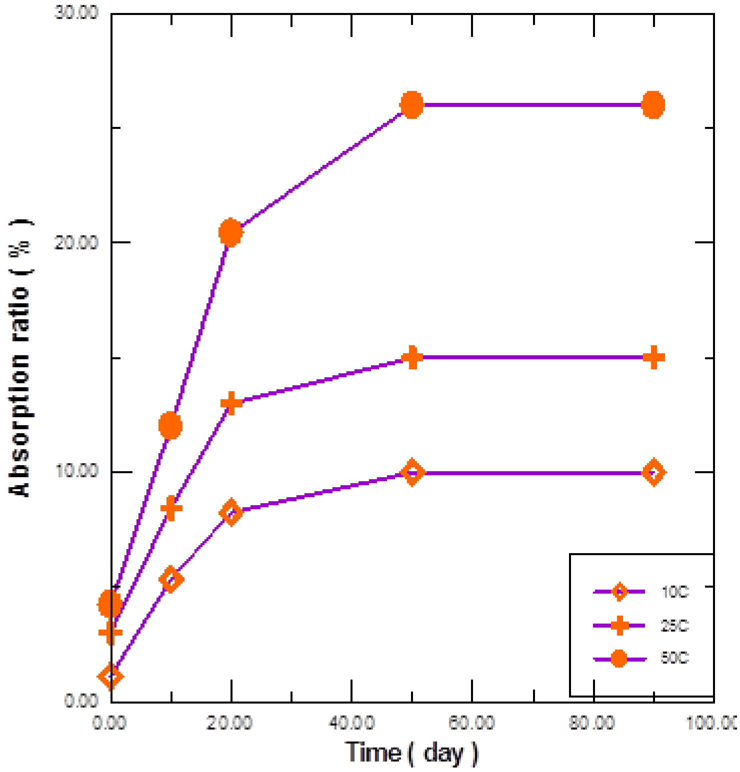

Fig (3) Show change in elongation percentage of PET bottle containing orange drink(50 ppm) at different interval times .

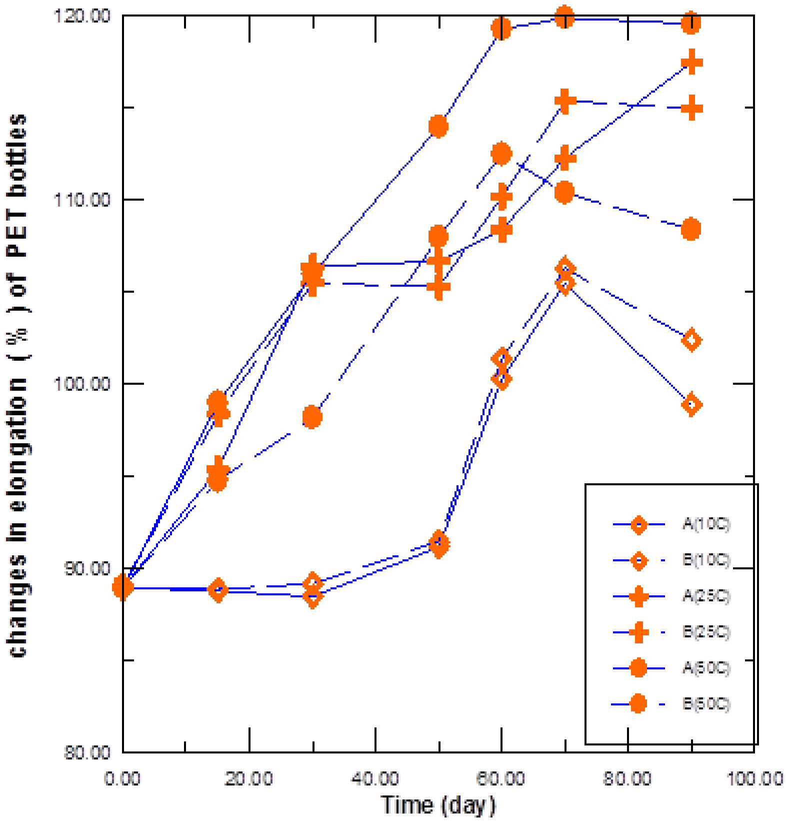

Fig (4) Show absorption percentage for orange drink into (PET) bottles during interval different times .

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دراسة تأثير امتصاص فيتامين ج على الخصائص الميكانيكية لقناني شرب متعدد (الاثيلين واطئ الكثافة).

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الخلاصة :

هذا البحث يوضح تاثير امتصاصية فيتامين ج (حامض الاسكوربيك) بواسطة قناني متعدد (اثيلين تيرفثالايت) (PET) البلاستيكية المصنعة على الخواص الميكانيكية للعلب البلاستيكية والتي تحققت من خلال قوة الشد, ان نماذج بولي اثيلين تيرفثالايت بوزن (50 ppm) كتركيز اولي لفيتامين سي , تم تخزينة حوالي تسعين يوما وبدرجات حرارية مختلفة (10 , 25 , 50) °م وبعدمرور تلك الفترة الزمنية على التخزين يتم قياس بعض الفحوصات الميكانيكية عليه كقوة الشد ومعامل المرونة والاستطالة . تتم مقارنة تاثير فيتامين سي لقناني بولي اثيلين تيرفثالايت والمحتوية على عصير البرتقال بتركيز (50 ppm) ضد قناني بولي اثيلين تيرفثالايت المحتوية على عصير البرتقال بدون تركيز مضاف من فيتامين ج. التاثير الاكبر لفيتامين ج من خلال الاختبارات الميكانيكية لوحظ من خلال النماذج المخزونة في (50°C) والتي استطاعت من خلالها ان تحقق نسب امتصاص عالية من فيتامين سي , كما لوحظ ان قوة الشد ومعامل المرونة تقل مع زيادة الامتصاصية على عكس الاستطالة التي تزداد نسبتها مع زيادة الامتصاصية .