Effect of varieties, heat treatment and storage at different conditions on mechanical properties of cherry fruits

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ABSTRACT

Mechanical properties of three sweet Cherries varieties (Greece, Spain and German sweet cherries) and one sour cherry variety (German sour cherry) fruits were studied by using Instron Universal Testing Machine model 4301. The effects of varieties and storage at different temperatures for Cherries fruits on physico-mechanical properties were studied by using the flat plate compression test.. The maximum compression force for cherry fruit is the most suitable single mechanical parameter that can be used to classify the batches unambiguously and to distinguish between varieties. The maximum compression force varied from 26.97 N (Spanish sweet cherry) to 16.94 N (Werder German sweet cherry). The Young’s modulus ranged from 0.0315 MPa (Spanish sweet cherry) to 0.0197 MPa (Werder German sweet cherry). Maximum force, elastic modulus values and energy for all cherry fruits were decreased in the non chilled condition and with increasing storage time. The effect of the heat treatment on mechanical properties of cherries fruits was studied also.

Keywords: Sweet & sour cherry . Cherry varieties . Mechanical Properties . Compression test. Heat treatment .

INTRODUCTION

Western Europe produces 550 000 - 700 000 tones of sweet cherries, about 50 % of world production. The USA produces about 175 000 tones, half being marketed fresh and half processed, Ing-G (1998). Spanish cherries are of high quality and are gaining in importance in European markets. (25-35 % of Spain's cherry production export to European markets).

Fruits and vegetables are liable to mechanical damage such as bruising, cracking, splitting and compression associated with harvest, handling, transport and storage practices. Such mechanical damage is difficult to be quantified since it may arise at any stage in the post-harvest sequence from harvesting to consumption. Mechanical properties and textural characteristics depend on biochemical and biophysical changes occurring during ripening, transport and handling. Information on the mechanical properties of fruits is of use in characterisation of material, fixing optimum time for harvest, separation from undesirable materials, texture and quality evaluation, assessment of the extent and nature of damage in collection, handling, storage and processing, and identification of basic anatomical structure (Gurhan *et al.,* 2001). Sweet cherry fruit firmness is one of the most important quality factors as firm fruits are desired for fresh eating, handling, marketing and shipping Choi *et al.*(2002). Cherries of three varieties were compressed between two plates in the loading-unloading test to determine the energy dissipated during the test. After compression, the bruise volume of the deformed fruit was determined by Blahovec and Patocka (1996). The present work was done to determine the mechanical characteristics of cherry fruits. And evaluation of the change in mechanical characteristics cherry fruits during the storage at different temperatures. Study the effect of heat treatments on mechanical characteristics of cherry fruits.

2.MATERIALS AND METHODS

2.1.Materials:

Cherry fruits:

Cherry fruits at the ripe stage were obtained :

Greece cherries:

Mature Greece sweet cherry fruit (*Prunus avium L.*) were obtained from Greece company (AGROCOM S.A. 58300 Kria Vrissi, Greece).

Spain cherries:

Spanish Cerezas sweet cherry fruit (*Prunus avium L.*) were obtained from Spanish company (Agrup. Coops. Valle del Jerte Ctra Nacional110, Km.381-10614 Valdastillas (Caceres) Spain).

German sweet cherries:

Werder German Sweet cherry fruit (*Prunus avium L.*) were obtained from Werder company (Werder Frucht, Plötziner Str.31, 14542 Glindow, Germany).

German sour cherries:

German Sour cherry fruit (*Prunus cerasus L.*) were obtained from company (VEDS Vertriebsgesellschaft für Obst mbH Haupt strasse 2a, D-01809 Dohna OT Röhrsdorf, Brandenburg, Germany).

All cherry fruits were selected freedom from defects by careful visual inspection, The fruits were cleaned to remove all foreign matter such as dust, dirty, stones and chaff as well as immature and broken fruits. All cherry fruits were growing in season 2002 and 2003.

2.2.Methods:

2.2.1. Mechanical properties measurements:

All mechanical properties were made using the Instron Universal Testing Machine (Model 4301) equipped with:

Flat plate probe (with 100 and 500 N load cell) for compression cherry fruits.

The force corresponding to the maximum compression is defined as the maximum force (F_{max}). The maximum puncture force (F_{max}) was measured in Newton. The mean slope of the force–deformation curve was taken as stiffness and the actual area under the curve was expressed as work (Energy) which has been referred to as toughness in the literature (Thiagu *et al.,* 1993).

2.2.2. Measurement of mechanical properties of cherry fruits:

Cherry samples were weighed, and cherry diameters were measured. The fruit of each variety sample was divided into two parts;

The first part of cherries was stored at 4 ± 0.5 °C, 90 ± 5% relative humidity [chilled (C)]. ***The second*** part of cherries was stored at 25 ± 0.5 °C, 90 ± 5% relative humidity [non chilled (NC)], (Kappel *et al.*, 2002).

Samples of 50 cherries perfect fruits of the same color and diameter were selected from each variety every day. Fruits with stems were tempered at 20 °C by using K-type thermocouples Testo® 112 and compressed between two plates at the same deformation rate of 50 $mm.min^{-1}$ (Alonso and Alique, 2004). The tests were performed using an Instron universal testing machine, model 4301.The Instron has been successfully used to measure firmness and all mechanical parameters in cherries fruits (Brown, 1988; Mitcham *et al.,* 1998 and Bernalte *et al.*,2003).

2.2.3. Heat treatment of fruits and mechanical parameters measurement:

Cherry fruits were heated at 50, 60, 70, 80 and 90 °C for 10, 7.5, 5, 2.5 and 1.5 min, respectively, in a steam jacketed kettle (thermostatically controlled ± 1°C), cooled in tap water and drained according to Abbott *et al.* (2000). The mechanical properties for samples were made.

3. RESULTS AND DISCUSSION

3.1. Effect of cherry varieties and storage at different conditions on mechanical properties of cherry fruits:

Cherries are soft fleshy fruits with a stone. Cherry pulp is much softer than the skin. The water content of the flesh is about 90 %, and its modulus of elasticity is in some cases only one hundredth of the modulus of elasticity of the fruit skin (Blahovec *et al.*,1995). These special characteristics give the cherry certain properties of fibrosity, turgidity, and inelasticity which make it difficult to perform mechanical assays to reach a correct assessment of texture differences between different degrees of ripening for a specific variety of cherry, and also between different varieties of this species. While, a considerable part of the cherry production is exported, the expansion of fresh cherry exports is hampered by relatively short storage life of this fruit (Paull, 1999).

In this part of study, we have tested some mechanical parameters of some varieties of sweet and sour cherries by using compression test. Also study the effect of storage under different conditions on the mechanical parameters of cherry. The mechanical properties of cherry fruits were measured until all fruits were very firm when touched by hand. It is very difficult to determine the texture. The data obtained in the compression test are given in Tables (1-4) and Figs.(1- 6). Data are expressed as the mean values of 50 fruits and standard errors are given.

Firmness results were expressed as the maximum force (N) to compress the whole cherries, Young's modulus (Chord) is obtained from the slope of a straight line "least squares fit", made through the steepest linear region of the testing curve between 2-6 mm, and the Energy (the area under loading curve to between 2-10 mm). There was noticeable different between cherry varieties during chilling and non chilling storage in all physico-mechanical parameters under investigation. The maximum compression force varied from 26.97 N (Spanish sweet cherry) to 16.94 N (Werder German sweet cherry). The Young's modulus (Chord) ranged from 0.0315 MPa (Spanish sweet cherry) to 0.0197 MPa (Werder German sweet cherry). The maximum compression force and all mechanical parameters decreased with increasing storage time for all cherry varieties under assay. Data of Tables (1-4), indicated that chilling conditions effected on shelf live for all cherry varieties. Cherry stored in non chilling storage were softer than the cherries stored at the chilling conditions. Cliff *et al.*(1996) although cherry condition and freshness have been identified as quality factors in consumer purchase decisions, they should not be a factor in cultivar selection. cherry color, size and texture are the most important in consumer acceptability.

German sweet cherry fruits:

The German sweet cherry fruits have a diameter (width) ranged from 2.45 to2.29 cm, and a length ranged from 2.82 to 2.42 cm, the diameter and length are the mean values of 50 fruits Table (1). After 15 days storage at 4 ± 0.5 °C, 90 ± 5% relative humidity [chilled (C)] the maximum force values of the cherries decreased, and all mechanical parameters were decreased with increasing in the storage time. In general, texture change during the storage of fruit involved cell wall degradation, is consisted of a dissolution of the pectin-rich middle lamella region. These results were in agreement with Bartley and Knee, 1982; Bernalte *et al*., 2003.

On the other hand, the cherries which were stored at room temperature 25 ± 0.5 °C, 90 ± 5% relative humidity [non-chilled (NC)] stayed only 8 days. The change in all mechanical parameters for (NC) cherry was higher than (C) cherry. These results caused by correlation between enzyme activity and chilling. Bernalte *et al.* (2003) suggested that the drop in enzyme activity during chilling increasing the shelf life for cherry fruits from 15 to 8 days for chilled and non chilled cherry, respectively. This fact suggested that the chilled cherry fruit, after 15 days of storage, should not stay at the point of sale. While, non chilled cherry fruit stay 8 days only. From the results of this part of study, the temperature and conditions of storage must be controlled during the storage of cherry fruit.

Table(1): Physico-mechanical parameters for Werder German sweet cherry fruits stored under different conditions.

Treatment	Storage time	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	(days)	gm	cm	cm	N	MPa	J
Control	0	7.458±0.097	2.45±0.050	2.82±0.047	16.94±0.67	0.0197±0.001	0.0915±0.002
Chilled (4 °C)	1	7.295±0.151	2.40±0.025	2.78±0.041	15.92±0.70	0.0197±0.000	0.0914±0.002
	2	7.318±0.174	2.42±0.046	2.75±0.057	15.30±0.40	0.0189±0.001	0.0913±0.002
	3	7.337±0.180	2.45±0.043	2.73±0.055	14.98±0.31	0.0177±0.001	0.0904±0.001
	4	7.263±0.132	2.44±0.032	2.68±0.052	14.45±0.46	0.0176±0.001	0.0874±0.002
	5	7.197±0.169	2.41±0.016	2.65±0.036	13.71±0.34	0.0167±0.001	0.0784±0.003
	6	7.186±0.251	2.39±0.072	2.66±0.058	13.35±0.29	0.0157±0.001	0.0781±0.002
	7	7.172±0.144	2.37±0.044	2.61±0.059	12.73±0.38	0.015±0.0004	0.0744±0.002
	8	7.176±0.183	2.38±0.054	2.58±0.027	11.83±0.27	0.0143±0.001	0.0722±0.001
	9	7.146±0.161	2.35±0.044	2.60±0.048	11.12±0.27	0.0135±0.000	0.0712±0.001
	10	7.185±0.135	2.37±0.037	2.59±0.024	10.76±0.25	0.0128±0.000	0.0699±0.002
	11	7.184±0.168	2.38±0.029	2.57±0.036	10.43±0.41	0.0118±0.000	0.0675±0.001
	12	7.174±0.178	2.35±0.022	2.56±0.042	10.17±0.26	0.0106±0.001	0.0644±0.002
	13	7.096±0.218	2.34±0.023	2.54±0.039	9.44±0.288	0.0098±0.000	0.0608±0.001
	14	6.961±0.140	2.25±0.037	2.45±0.023	8.48±0.35	0.0091±0.000	0.0543±0.002
	15	7.008±0.125	2.29±0.046	2.43±0.044	7.51±0.19	0.0085±0.001	0.052±0.0012
Non chilled (25 °C)	1	7.465±0.135	2.47±0.045	2.80±0.033	15.36±0.42	0.0183±0.001	0.0877±0.003
	2	7.324±0.173	2.46±0.019	2.79±0.024	14.69±0.32	0.0177±0.001	0.0842±0.002
	3	7.286±0.167	2.44±0.023	2.75±0.051	14.36±0.34	0.0173±0.001	0.0839±0.002
	4	7.263±0.151	2.42±0.026	2.75±0.047	13.06±0.47	0.0149±0.001	0.0772±0.002
	5	7.261±0.194	2.39±0.038	2.69±0.044	11.86±0.44	0.0136±0.001	0.0686±0.003
	6	7.096±0.204	2.35±0.041	2.65±0.036	10.65±0.38	0.0114±0.001	0.056±0.003
	7	7.082±0.117	2.28±0.026	2.59±0.052	9.94±0.40	0.0102±0.000	0.0506±0.002
	8	6.991±0.222	2.29±0.054	2.47±0.067	6.91±0.50	0.008±0.000	0.0367±0.001

Spanish sweet cherry fruits:

Little is known about the influence of storage and variety on mechanical parameters of cherry fruits. Recently, there has been much interest in new sweet cherry cultivars from around the world to fill various marketing niches by extending the maturity season and to solve production problems, such as rain-induced cracking, shelf-incompatibility, and fruit softness (Kappel *et al.*, 1996)**.** What constitutes a "good" sweet cherry cultivar's is open to debate, but fruit size and texture are all considered important fruit quality traits, Christensen (1995).

Table (2): Physico-mechanical parameters for Spanish sweet cherry fruits stored under different conditions:

Treatment	Storage time	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	(days)	gm	cm	cm	N	MPa	J
Control	0	9.108±0.160	2.41±0.048	3.02±0.065	26.97±0.41	0.0315±0.001	0.1114±0.004
Chilled (4 °C)	1	9.105±0.191	2.43±0.051	3.01±0.038	25.50±0.42	0.0299±0.001	0.1057±0.004
	2	8.999±0.265	2.41±0.022	2.96±0.052	23.91±0.47	0.0269±0.001	0.103±0.004
	3	8.972±0.253	2.40±0.064	2.93±0.043	22.39±0.45	0.0242±0.001	0.0985±0.003
	4	8.831±0.24	2.36±0.047	2.92±0.041	20.92±0.42	0.0229±0.004	0.0904±0.002
	5	8.781±0.179	2.37±0.037	2.87±0.032	18.37±0.60	0.0202±0.001	0.0856±0.003
	6	8.709±0.138	2.37±0.053	2.82±0.021	15.57±0.52	0.0186±0.001	0.0777±0.003
	7	8.704±0.142	2.35±0.019	2.83±0.064	13.82±0.62	0.0153±0.001	0.0684±0.004
	8	8.662±0.162	2.32±0.038	2.80±0.046	12.26±0.51	0.0149±0.001	0.0565±0.004
	9	8.627±0.136	2.30±0.032	2.77±0.016	12.20±0.44	0.0136±0.001	0.0508±0.002
	10	8.549±0.186	2.24±0.075	2.78±0.068	10.72±0.47	0.0116±0.001	0.0457±0.002
	11	8.518±0.189	2.25±0.038	2.74±0.029	8.00±0.34	0.0089±0.000	0.034±0.002
	12	8.552±0.107	2.25±0.028	2.76±0.033	7.17±0.15	0.0081±0.000	0.0323±0.001
	13	8.533±0.168	2.24±0.021	2.75±0.024	6.83±0.49	0.0069±0.001	0.0304±0.004
Non chilled (25 °C)	1	8.977±0.182	2.40±0.072	3.00±0.051	23.52±0.44	0.0274±0.001	0.0977±0.003
	2	8.944±0.233	2.38±0.063	2.97±0.062	21.06±0.54	0.0201±0.000	0.0819±0.003
	3	8.857±0.237	2.35±0.068	2.89±0.054	13.69±0.50	0.0143±0.001	0.0663±0.003
	4	8.791±0.123	2.31±0.042	2.83±0.048	9.90±0.56	0.0114±0.001	0.0386±0.003
	5	8.782±0.148	2.29±0.051	2.79±0.057	8.41±0.55	0.0087±0.000	0.0318±0.002
	6	8.725±0.164	2.27±0.064	2.79±0.059	6.36±0.47	0.0071±0.005	0.0273±0.004

The results of physico-mechanical parameters for Spanish sweet cherry fruits were shown in Table (2). Fruit weight average ranged between 9.11 to 8.53 g, fruit diameter ranged between 2.41 to 2.24 cm and fruit length ranged between 3.02 to 2.75 cm. These results were agreement with Yamaguchi *et al.* (2002); Christensen, 1995; Kappel *et al.* (1996) and Drake and Fellman (1987) who found a significant correlations between cherry fruit weight and firmness. In Werder sweet cherry fruits the weight ranged between 7.40 to 6.96 g and the maximum force ranged between 16.94 to 6.91 N. While, the Spanish cherry weight ranged between 9.11 to 8.52 g and the maximum force ranged between 26.97 to 6.36 N. The same results also obtained in Young's Modulus and energy. The values of those parameters in Spanish cherry were higher than the same parameters in Werder cherry.

Greece sweet cherry fruits:

Fruit weight can be used to indicate maturity and is correlated with total solid in cherry fruit. In Table (3) some physico-mechanical parameters for Greece sweet cherry fruits were showed.

The weight loss during storage was 9.87 % and 7.04 % for chilled and non chilled Greece cherry fruits, respectively. The diameter loss was 7.76 % and 4.70 %, the length loss was 9.68 % and 2.94 % for chilled and non chilled fruits, respectively. While the loss in texture parameters was higher loss during storage. The maximum force loss during storage was 72.65 % and 69.07 %, the young's modulus loss was 65.25 % and 62.64 % and energy loss during storage was 63.13 % and 55.32 % for chilled and non chilled fruits, respectively. After 6 days storage at C and NC conditions, all the mechanical parameters for Greece cherry presented less loss for C than the NC conditions.

Table (3): Physico-Mechanical parameters for Greece sweet cherry fruits stored under different conditions.

Treatment	Storage time	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	(days)	gm	cm	cm	N	MPa	J
Control	0	6.474±0.121	2.32±0.035	2.79±0.036	26.65±0.71	0.0282±0.001	0.0990±0.005
Chilled (4 °C)	1	6.219±0.124	2.31±0.044	2.73±0.024	23.87±0.57	0.0269±0.001	0.0821±0.003
	2	6.221±0.145	2.33±0.042	2.71±0.037	22.618±0.61	0.0258±0.001	0.0803±0.002
	3	6.376±0.157	2.31±0.036	2.74±0.059	20.29±0.40	0.0254±0.001	0.0758±0.002
	4	6.178±0.154	2.27±0.047	2.70±0.033	19.97±0.48	0.024±0.001	0.0726±0.002
	5	5.955±0.144	2.22±0.023	2.67±0.021	18.26±0.37	0.0228±0.001	0.0688±0.002
	6	5.997±0.138	2.25±0.021	2.66±0.026	17.69±0.37	0.0215±0.001	0.0657±0.002
	7	5.919±0.103	2.23±0.054	2.64±0.012	16.653±0.44	0.0196±0.001	0.0616±0.002
	8	5.904±0.132	2.21±0.048	2.62±0.019	15.05±0.50	0.0187±0.001	0.0585±0.001
	9	5.909±0.078	2.21±0.017	2.63±0.020	13.35±0.29	0.0158±0.001	0.0553±0.001
	10	5.839±0.112	2.14±0.046	2.59±0.051	12.46±0.30	0.0144±0.001	0.0539±0.002
	11	5.837±0.107	2.15±0.053	2.55±0.074	11.04±0.18	0.0123±0.001	0.0476±0.002
	12	5.833±0.096	2.12±0.027	2.53±0.046	9.68±0.18	0.0106±0.001	0.0455±0.001
	13	5.835±0.111	2.14±0.025	2.52±0.031	7.29±0.29	0.0098±0.000	0.0365±0.002
Non chilled (25 °C)	1	6.403±0.152	2.34±0.022	2.72±0.035	22.86±0.70	0.0265±0.001	0.0808±0.002
	2	6.271±0.191	2.27±0.026	2.67±0.019	19.11±0.68	0.0239±0.001	0.0687±0.002
	3	6.158±0.143	2.23±0.048	2.65±0.050	14.08±0.48	0.0204±0.001	0.0611±0.004
	4	5.911±0.138	2.22±0.042	2.59±0.044	12.51±0.26	0.0180±0.001	0.0501±0.002
	5	5.934±0.127	2.22±0.075	2.62±0.047	10.24±0.32	0.0134±0.001	0.0433±0.001
	6	5.952±0.147	2.23±0.062	2.64±0.069	7.07±0.36	0.0099±0.000	0.0361±0.001

German sour cherry fruit:

The values of physico-mechanical parameters of German sour cherry fruit are presented in Table (4). The firmness (maximum force) of sour cherry was lower after 6 days at non chilled. While the maximum force was found the lower after 11 days at chilled condition. All mechanical parameters of German sour cherry fruit decreased with increasing storage days under two conditions. Decrease in maximum force with storage days was also observed for pear by Galvis-Sanchez *et al.* (2004).

Table (4): Physico-Mechanical parameters for German sour cherry fruit stored under different conditions:

Treatment	Storage time	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	(days)	gm	cm	cm	N	MPa	J
Control	0	5.607±0.183	2.624±0.026	2.135±0.023	19.93±0.48	0.0224±0.001	0.0817±0.002
Chilled (4 °C)	1	5.575±0.123	2.456±0.031	2.151±0.025	17.86±0.40	0.0210±0.001	0.0807±0.001
	2	5.363±0.077	2.533±0.034	2.138±0.027	17.20±0.41	0.0182±0.001	0.0741±0.001
	3	5.348±0.076	2.426±0.052	2.085±0.025	16.36±0.56	0.0165±0.001	0.0727±0.002
	4	5.108±0.073	2.381±0.067	2.127±0.028	16.00±0.64	0.0151±0.001	0.0690±0.001
	5	5.096±0.073	2.393±0.041	2.096±0.021	14.58±0.29	0.0120±0.000	0.0617±0.002
	6	5.087±0.073	2.385±0.018	2.125±0.022	13.49±0.41	0.0110±0.000	0.0603±0.002
	7	5.079±0.073	2.354±0.065	2.091±0.019	12.00±0.14	0.0100±0.000	0.0545±0.002
	8	5.026±0.072	2.332±0.018	2.078±0.02	11.20±0.21	0.0089±0.000	0.0519±0.001
	9	4.986±0.069	2.345±0.043	2.082±0.023	10.93±0.24	0.0087±0.001	0.0508±0.002
	10	4.948±0.071	2.317±0.062	2.071±0.02	9.66±0.24	0.0074±0.001	0.0449±0.001
	11	4.997±0.098	2.295±0.041	2.068±0.023	7.53±0.29	0.0067±0.000	0.0281±0.001
Non Chilled (25 °C)	1	5.485±0.179	2.545±0.027	2.168±0.026	16.67±0.64	0.0187±0.000	0.0692±0.002
	2	5.335±0.076	2.448±0.021	2.095±0.02	15.15±0.63	0.0163±0.000	0.0652±0.002
	3	5.345±0.076	2.397±0.039	2.016±0.046	12.46±0.45	0.0144±0.001	0.0596±0.002
	4	5.106±0.073	2.353±0.015	2.063±0.023	11.57±0.42	0.0114±0.001	0.0529±0.003
	5	5.089±0.073	2.279±0.047	2.115±0.023	10.57±0.27	0.0105±0.000	0.0517±0.001
	6	5.003±0.146	2.182±0.019	2.075±0.009	7.01±0.15	0.0077±0.000	0.0380±0.001

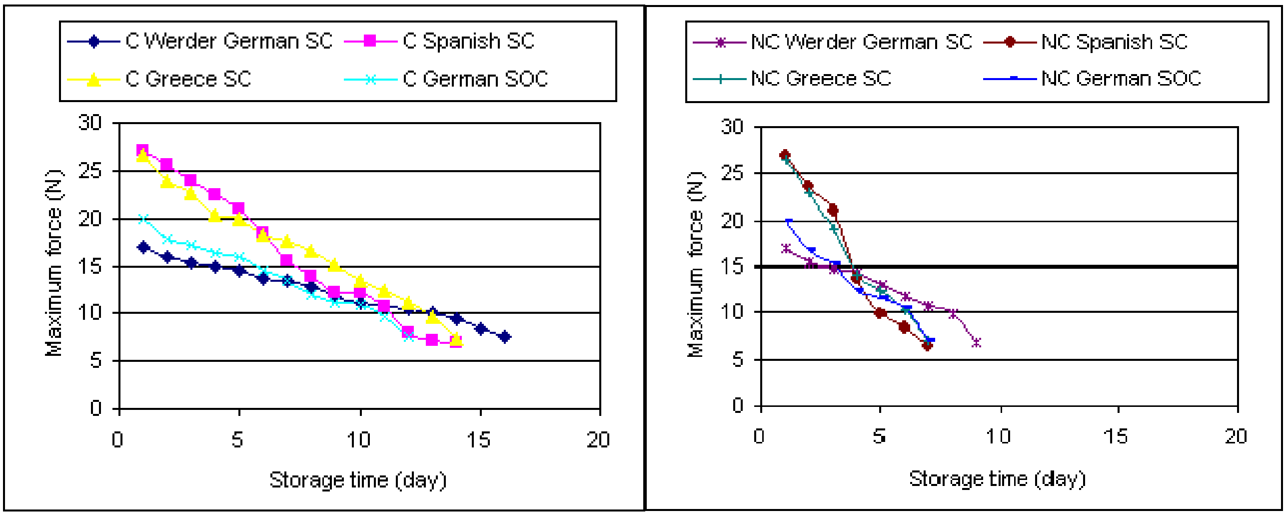

Fig. (1): ***Maximum force (N) for cherry fruits stored at chilled(C) and non chilled (NC) conditions***

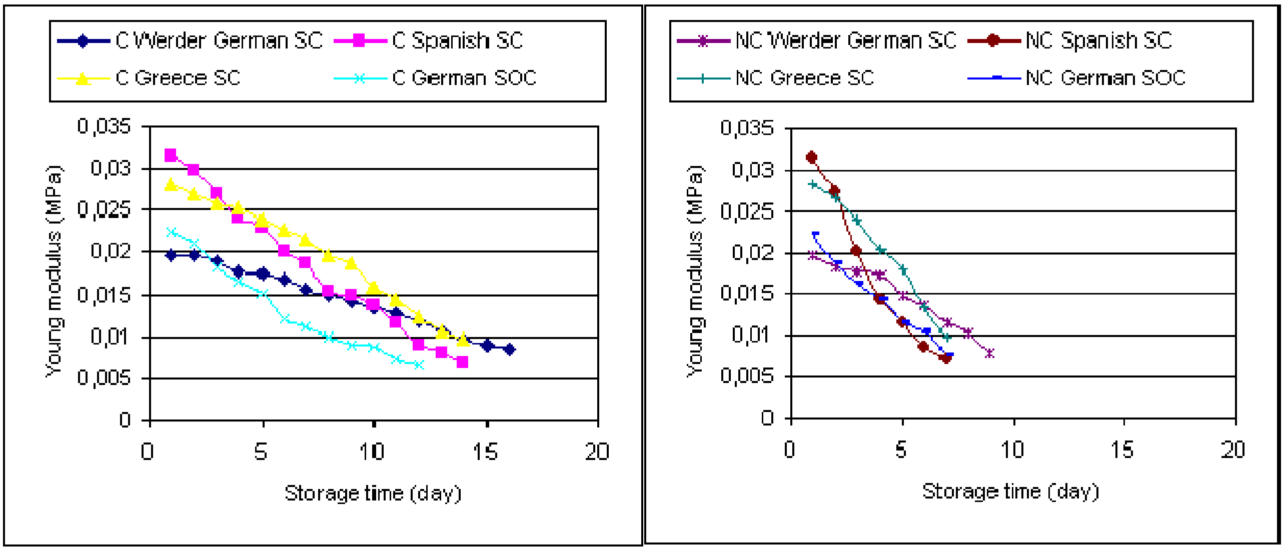

Fig. (2): ***Young modulus (MPa) for cherry fruits stored at chilled (C) and non chilled (NC) conditions***

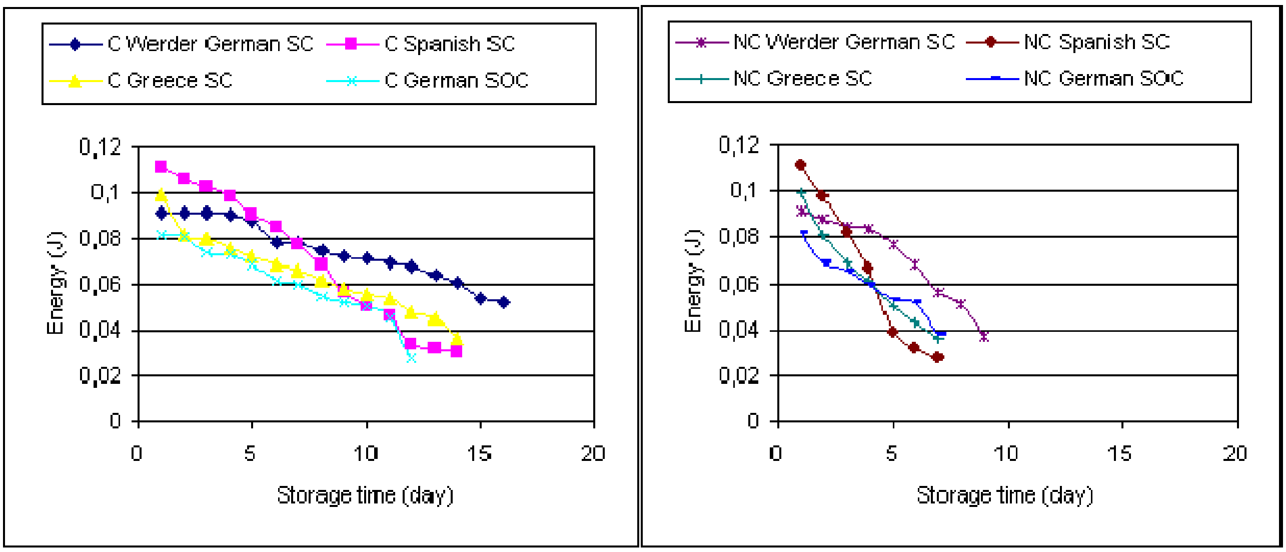

Fig. (3): ***Energy (J) for cherry fruits stored at chilled (C) and non chilled (NC) conditions***

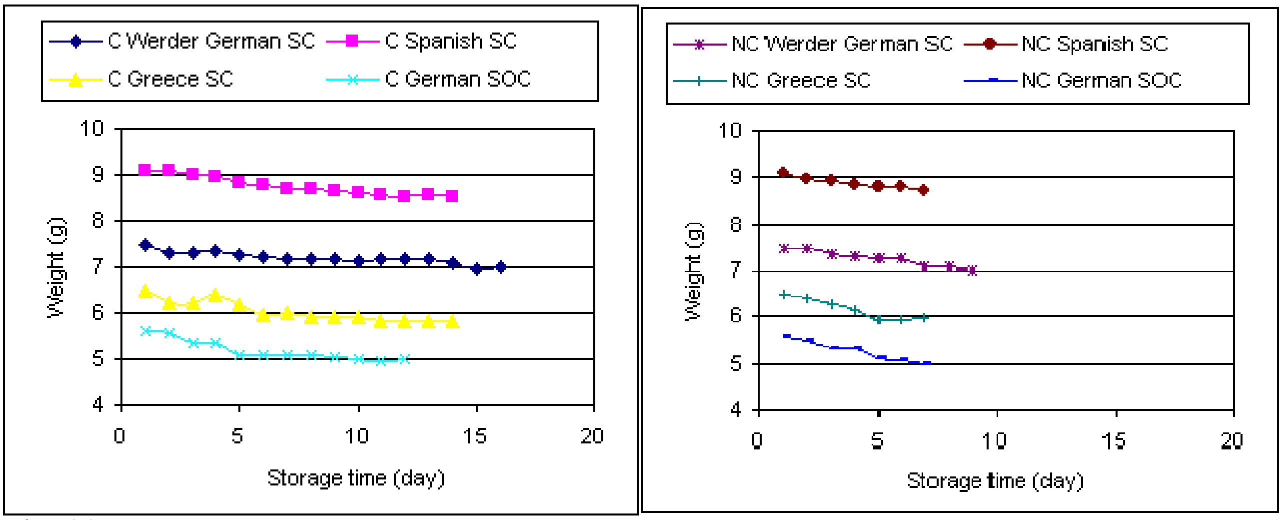

Fig. (4): ***Weight (g) for cherry fruits stored at chilled (C) and non chilled (NC) conditions***

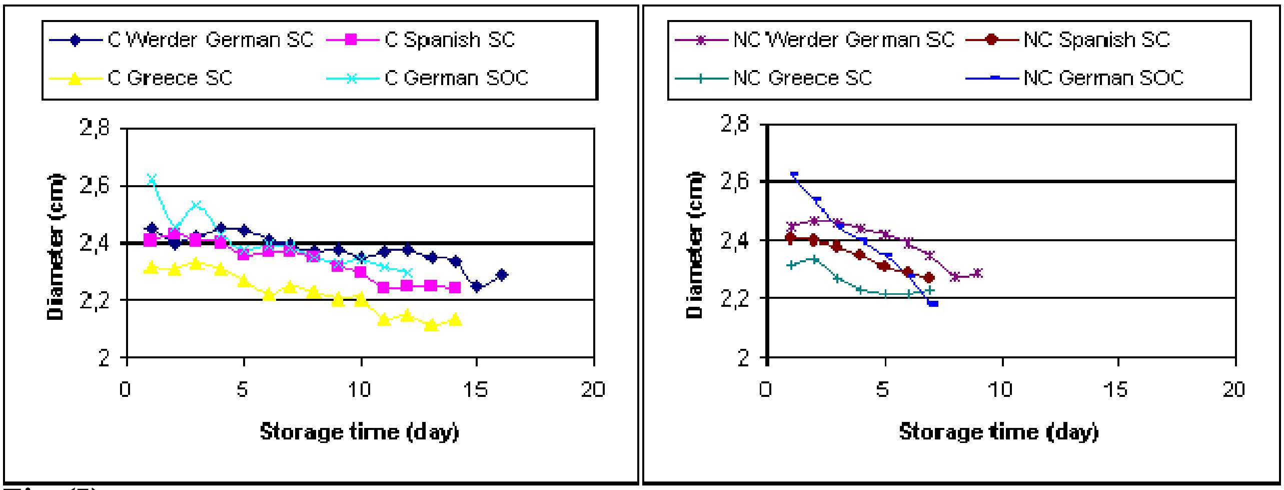

Fig. (5): ***Diameter (cm) for cherry fruits stored at chilled (C) and non chilled (NC) conditions***

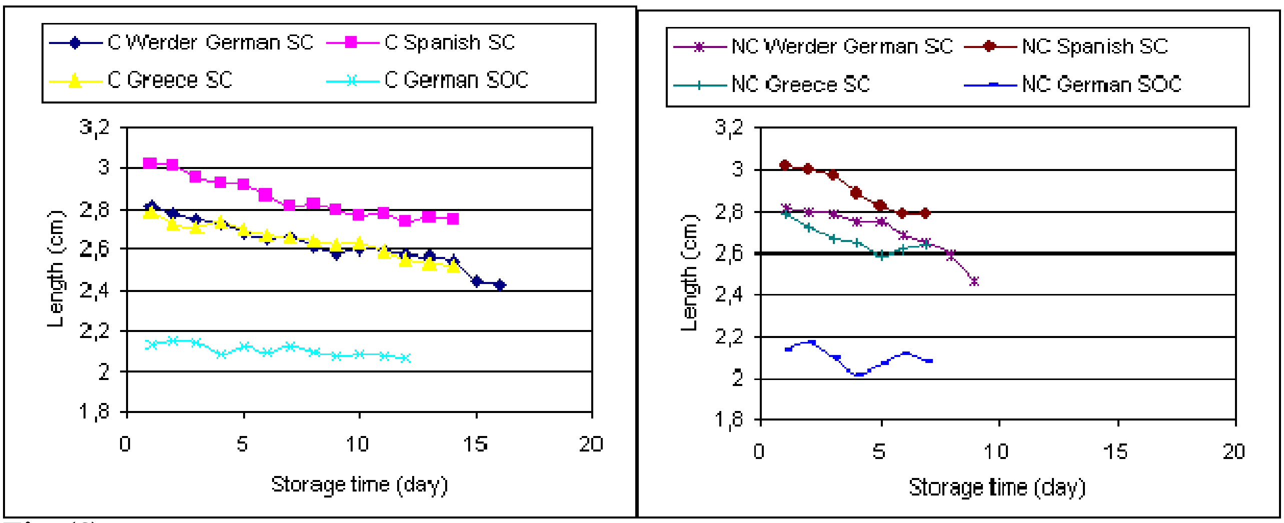

Fig. (6): ***Length (cm) for cherry fruits stored at chilled (C) and non chilled (NC) conditions***

3.2. Effect of heat treatment on mechanical properties of cherry fruits:

Sweet and sour German cherries fruits were used in this part of study. The samples were divided into 6 groups: 5 for heat treatment (50 °C for 10 min, 60 °C for 7.5 min, 70 °C for 5 min, 80 °C for 2.5 min and 90 °C for 1.5 min) and one as a control. After preheating the fruits were cooled in tap water, drained and mechanical parameters were massed.

The means and standard errors of the 50 cherry fruits heated at different temperatures and different times were tabulated in Tables (5-6) for sweet and sour German cherries fruits, respectively.

The Maximum force, Young's Modulus (Chord) and Energy for cherry heated at (90 °C for 1.5 min) were higher than cherry heated at (80 °C for 2.5 min). Mechanical parameters of sweet cherries at temperatures 50, 60, 70 and 80 °C decreased with increasing temperature. The same results were observed by sour cherries, the mechanical parameters of sour cherry decreased at temperatures 50, 60, 70 and 80 °C. Increased the mechanical parameters of cherries as a result of low- temperature in thermal treatment has been attributed to an increase in pectic acid (EDTA-soluble fraction), and to a partial reduction in both soluble pectic materials and degree of de-esterification of pectin by pectin esterase, Alonso *et al.,* (1993; 1994 and 1997) and Lin and Schyvens (1995). Treatment at low temperature cause loss of membrane selective permeability, giving rise to diffusion of cations to the cell wall (Alonso *et al.*, 1997).

Table(5): Effect of heat treatment on some physico-mechanical parameters for Werder German sweet cherry fruit:

Treatment	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	gm	cm	cm	N	MPa	J
Control	7.46±0.10	2.45±0.05	2.82±0.05	16.94±0.67	0.0197±0.001	0.0915±0.002
50 °C/ 10 min	7.39±0.12	2.47±0.02	2.76±0.04	14.93±0.52	0.0184±0.001	0.0441±0.000
60 °C/ 7.5 min	7.37±0.11	2.46±0.02	2.79±0.04	10.32±0.47	0.0157±0.001	0.0335±0.000
70 °C/ 5 min	7.37±0.15	2.49±0.03	2.72±0.05	9.91±0.42	0.0142±0.000	0.0292±0.001
80 °C/ 2.5 min	7.43±0.14	2.44±0.02	2.84±0.03	9.69±0.47	0.0139±0.000	0.0251±0.001
90 °C/ 1.5 min	7.45±0.14	2.48±0.03	2.82±0.03	9.86±0.44	0.0144±0.000	0.0282±0.000

Table (6):Effect of heat treatment on some physico-mechanical parameters for German sour cherry fruit:

Treatment	Weight	Diameter	Length	Maximum Force	Young's Modulus (Chord)	Energy (2-10mm)
	gm	cm	cm	N	MPa	J
Control	5.61±0.18	2.62±0.03	2.14±0.02	19.93±0.48	0.0224±0.001	0.0817±0.002
50 °C/ 10 min	5.67±0.13	2.46±0.02	2.15±0.03	11.54±0.35	0.0158±0.001	0.0474±0.001
60 °C/ 7.5 min	5.68±0.11	2.53±0.02	2.14±0.02	10.29±0.23	0.0117±0.002	0.0380±0.000
70 °C/ 5 min	5.61±0.11	2.43±0.03	2.09±0.03	9.65±0.27	0.0077±0.001	0.0327±0.001
80 °C/ 2.5 min	5.62±0.13	2.38±0.03	2.13±0.02	9.23±0.42	0.0072±0.001	0.0255±0.001
90 °C/ 1.5 min	5.59±0.11	2.39±0.03	2.10±0.02	10.42±0.34	0.0094±0.001	0.0299±0.001

Conclusions:

Apparently, chilling was the most important factor affecting the texture of cherries fruits, whereas cherry variety was the secondary factor. The compression test and the mechanical parameters are an excellent indicator for shelf life of cherry. The mechanical parameters are the most useful assay for the correct temperature and time conditions for storage and handling of cherry fruits. The maximum compression force is the most suitable single mechanical parameter that can be used to classify the batches unambiguously and to distinguish between varieties. Fruit size is a very important criteria for commercial market value. All tested cherry had a good fruit weight and size. In the end using raw material measurements to describe the quality of a final product would be a great benefit for the industry. The best storage conditions of cherries to keep fruit fresher were temperature around 4 °C and high relative humidity (90-95 %). Heat treated cherry had higher different mechanical parameters values than controls. Maximum force for heat treated cherries was lowest for controls, indicating that these were softest.

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