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Storage quality in different brines of pickled capers *(Capparis spp.)*

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RESUMEN

Calidad del almacenamiento en diferentes salmueras de alcaparras encurtidas (*Capparis* spp.).

Se encurtieron durante dos meses botones florales de tamaño intermedio de (*Capparis spinosa* L. var. *spinosa* y *Capparis ovata* Desf. var. *canescens* (Coss) recogidos de plantas silvestres. Las alcaparras después de la fermentación se conservaron en salmueras del 10% y 20%. Las alcaparras fermentadas fueron mantenidas durante 180 días en salmueras usadas o recién preparadas (frescas) del 10 y 20%, determinándose a intervalos la estabilidad durante la conservación por análisis físicos, químicos y microbiológicos. La calidad del producto se mantuvo en todas las muestras de alcaparras fermentadas durante los 180 días, tanto en 10% como en 20% y en salmueras usadas o frescas. La acidez durante la conservación fue mayor en salmueras usadas. El crecimiento de bacterias del ácido láctico se observó sólo en salmueras frescas del 10%, decreciendo desde el valor inicial en el caso de *C. ovata* y desde los 30 días para *C. spinosa.* Debido al escaso sedimento y a la textura más firme, *C. spinosa* fue preferida a *C. ovata.* Durante el almacenamiento en salmueras frescas, no se observó formación de sedimentos ni pérdida de flavor en ninguna de las especies. Los productos encurtidos pueden ser almacenados durante un largo período en salmueras frescas que contengan al menos un 10% de concentración salina.

PALABRAS-CLAVE: Alcaparra - Almacenamiento - Calidad - Conservación - Encurtido - Salmuera.

SUMMARY

Storage quality in different brines of pickled capers *(Capparis* spp).

Middle sized buds of *Capparis spinosa* L. var. *spinosa* and *Capparis ovata* Desf. var. *canescens* (Coss.) Heywood collected from wild plants were pickled for two months. The buds after the fermentation were processed in 10% and 20% brines. Storage stability of the fermented capers was determined by physical, chemical and microbiological analysis at certain interval in 10 and 20% old or fresh brines 180 days. Storaged in 10% and 20% old or fresh brines for 180 days of pickled buds of both species maintained the product quality in all samples. Acidity was higher in old brine during storage. Lactic acid bacteria (LAB) growth was observed only in 10% fresh brine, it decreased from initial and 30 days at *C. ovata* and *C. spinosa,* respectively. *C. spinosa,* compared with *C. ovata* was desirable due to low sediment and more firm texture. During storage of buds in fresh brines, sediment and off-flavour were not observed for both species. Pickled products can be stored in fresh brine long-term containing at least 10% salt concentration.

KEY-WORDS: Brine - Caper - Conservation - Pickling - Quality - Storage.

1. INTRODUCTION

Capers («kapari, kebere or gevil» in Turkish) are the flower buds of *Capparis* genus in the Capparaceae family, a plant of tropical and arid areas. Capers grow wildly at various regions of the world are used for several purposes since ancient times. Perennial shrub plant have thick and deep roots, lignify bulky on the high of about 50-100 cm, and are generally thorny and hairly.

Certain species and varieties of capers have been cultivated especially in Mediterranean regions, and have become an important economic plant in Italy and Spain for the last three decades. The plants show strong resistance to hard environmental conditions (rocky, inclination places, poor soils and limiting water, etc.), and could proliferate by the seed on cutting (Özcan and Akgül 1995, Akgül 1996).

Especially the fermented product from flower buds in Mediterranean countries had reestimated as a seasoning (Barbera 1991). Special pungent flavor is the result of number of sulphur-containing compounds formed by the hydrolysis of glucosides (Brevard *et al.,* 1992). The final product is a valuable ingredient in several foods (Gerhardt 1979; Akgül 1993).

Packed pickling products recently (about 3-5 thousand tons/year) have been exported from Turkey to European Countries. Quality and technological problems exist in the products obtained from wild plants (Özcan and Akgül 1995; Akgül 1996). Fermentation studies as regard capers arised in the few years except for product storage after fermentation. There is little information on storage of fermented capers in Italy and Spain. It was carried out work with regard to the composition of raw and fermented buds and the effect of brine and packing on product quality of capers (Alvarruiz *et al.,* 1990, Breward *et al.,* 1992, Özcan and Akgül 1990).

However, the rise of interest to the final-product needs long storage practices. More raw buds in conjunction with plant cultivation will be also processed.

The objective of this study was to determine the effect of various storage experiments on sensory, chemical and microbiological qualities of pickled capers from different plant species.

2. MATERIALS AND METHODS

Flower buds of *Capparis spinosa* L. var. *spinosa* and *Capparis ovata* Desf. var. *canescens* (Coss.) Heywood respectively were collected from wild plants in İçel (Büyükeceli-Gülnar) and Konya (Selçuklu) in june 1996. The buds classified in the size between 8 and 13 mm were processed in 10 % and 20 % (in equilibrium) brines for storage. Middle size ($8 < x \leq 13$ mm) buds were put into 3 L jars and brined at a pack-out ratio of 2/1 (brine/buds). Pickled products were stored to determine the storage stability, during 180 days in old and fresh brines at the same concentrations. The brines were analysed at certain intervals (0, 30, 60, 90 and 180 days) (Etchells and Bell 1976). Some chemical, physical and microbiological analysis of brines were done as four replication during storage. The chemical analysis were done according to AOAC (1984). Firmness was determined according to Chesson and Moore (1985), using Biological Material Test Instrument (VIBRO-METERS SA GM., FRIBOURG SWITZERLAND, Frequency range: 0-2200 Hz, Linearite: 0.05 % and working temperature: -10- (+50 °C) modified by Ögüt and Aydm (1991). Rogosa agar, nutrient agar, potatoes dextrose agar and Eosin Methylen Blue agar were used for lactic acid bacteria, total bacteria, yeast-mould and coliforms respectively. Results were analysed for statistical significance by analysis of variance (Minitab 1991) and differences among groups were established by Duncan method (MStat C 1991). Experiments and analyses were replicated and duplicated.

3. RESULTS AND DISCUSSION

Appearance Properties

Color of buds in old and fresh brines of both species at initial storage were yellowish green. *C. spinosa* buds were also the same colour in all brines after 30 days storage. From 60 days, color of *C. ovata* buds were bright in old brines and dull yellowish green in fresh ones. Colors of brines through storage had generally brownish red, however dull color was dominant at ones.

Flavor in fresh brine products according to old brines partly decreased, similar results were reported by Alvarruiz *et al.,* (1990). No sediment with fresh brine was observed and the buds reached rapidly to the bottom. Opening was not observed in buds of species for both brines. Tiny grayish spots on the surface of buds were less with fresh brines than the old ones. This fact was due to put in to fresh brine from old brines of fermented buds. Firmness of buds in fresh brines decreased partly but *C. spinosa* buds were more firm texture.

According to these results, color of buds in both species changed during storage. Color of *C. spinosa* was more yellowish green desired.

Fresh brines were beneficial for eliminating off-flavors. Also no sediment was observed, and thus fresh brine might suggest for product stability during storage. Furthermore, fresh brines resulted in reaching to the bottom of buds that exhibited advantage to color quality of storaged product. Bud firmness decreased partly, however, having an negative effect. In fresh brines, more firm buds of *C. spinosa* were superior to *C. ovata.*

Storage conditions of several fermented products may be affected through physical, chemical and microbiological properties of brine in conjunction with salt concentration (Sahin 1985).

Storage Characteristics

Brine analysis results of both species in middle size fermented buds at 10 % and 20 % old and fresh brines are given in Table I.

Relationship between acidity and pH values (on 60, 90 and 180 days) of 10 % and 20 % old and fresh brines during storage was statisticaly significant ($P < 0.01$). Lactic acid bacteria grewn in 10 % fresh brines of both species. On initial and 90-180 days difference between LAB value were significant at the $P < 0.05$ and $P < 0.01$ level, respectively. Differences between of both species firmness values in 20 % old and fresh brines on initial and 180 days respectively were significant at the $P < 0.05$ and $P < 0.01$ level.

Acidity values during storage were low at the samples with fresh brine of *C. ovata* and *C. spinosa.* pH decreased markedly in 10 % fresh brine as from initial to final storage.

Generally, total and coliform bacteria counts in old brines of *C. spinosa* were lower levels than other samples. Yeasts-moulds growth in 10 % and 20 % old brines at initial, 10 % old and fresh brines of *C. spinosa* through 90 days, and 10 % fresh brine of *C. ovata* was detected.

No important changes occurred in bud firmness during storage. Old and fresh brines had similar effects on firmness.

Acidity in old brines was usually higher than fresh brines during storage. Lactic acid bacteria (LAB) growth were observed only in 10 % fresh brine, it decreased as from initial and 30 days at *C. ovata* and *C. spinosa,* respectively. Firmness of bud was similar in all the samples. Results suggested that 10 % salt level was sufficient for storage of fermented capers.

Even low salt concentration (*ca* 10 %) prevented generally tissue softening through storage. Whereas, it was known that low salt concentrations and fungal originated pectinolitic enzymes resulted in softening of fermented products (Alvarruiz *et al.,* 1990; Fleming 1991).

Table I

Brine and firmness analysis during storage of capers buds (8 < x ≤ 13 mm)

Initial	Species	Salt Concentration (%)			
		10 O*	20 O	10 F**	20 F
		$\bar{x}$			
Acidity (%, lactic acid)	*C. spinosa*	0.8150 C***	0.7475 D	0.3075 G	0.2550 H
	C. ovata	1.2100 A	1.0975 B	0.5400 E	0.4400 F
pH	*C. spinosa*	4.3750	4.5050	4.7200	4.9400
	C. ovata	4.4750	4.4850	4.1850	4.9050
Salt (%)	*C. spinosa*	8.175 e****	17.425 a	8.657 d	17.387 c
	C. ovata	8.190 e	17.545 a	8.680 d	17.180 b
Lactic Acid Bacteria (CFU/ml) x 10^4	*C. spinosa*	-*****	—	70.00 a	—
	C. ovata	—	—	583.50 b	—
Total Bacteria (CFU/ml) x 10^4	*C. spinosa*	4.50 C	8.50 C	114.75 B	36.00 C
	C. ovata	831.50 A	27.00 C	56.50 C	13.00 C
Coliform Bacteria (CFU/ml) x 10^4	*C. spinosa*	2.7500	0.5000	—	0.5000
	C. ovata	14.7500	6.2500	4.7500	4.7500
Yeasts-Moulds (CFU/ml) x 10^4	*C. spinosa*	—	—	—	—
	C. ovata	0.25000	0.25000	—	—
Firmness (kg/cm^2)	*C. spinosa*	8.8325 cd	7.7800 f	9.5425 ab	9.6000 a
	C. ovata	9.3325 abc	8.4025 de	9.0400 bc	8.1625 ef
30 Days					
		$\bar{x}$			
Acidity (%, lactic acid)	*C. spinosa*	0.80250 c	0.66750 d	0.37500 f	0.26000 g
	C. ovata	1.07250 a	0.98000 b	0.65500 d	0.44250 e
pH	*C. spinosa*	4.4950 D	4.6550 B	4.3600 E	5.0550 A
	C. ovata	4.5850 C	4.6250 BC	3.67500 F	5.0200 A
Salt (%)	*C. spinosa*	8.267	17.360	8.287	17.533
	C. ovata	8.398	17.632	8.288	17.285
Lactic Acid Bacteria (CFU/ml) x 10^4	*C. spinosa*	—	—	154.500	—
	C. ovata	—	—	119.250	—
Total Bacteria (CFU/ml) x 10^4	*C. spinosa*	7.00 B	3.75 B	65.00 B	19.50 B
	C. ovata	705.00 A	30.25 B	14.75 B	15.00 B
Coliform Bacteria (CFU/ml) x 10^4	*C. spinosa*	4.250 BCD	2.750 CD	0.250 D	—
	C. ovata	82.750 A	7.000 BC	4.250 D	10.000 B
Yeasts-Moulds (CFU/ml) x 10^4	*C. spinosa*	—	—	—	—
	C. ovata	—	—	—	—
Firmness (kg/cm^2)	*C. spinosa*	9.0550	8.4300	9.4150	8.5725
	C. ovata	8.0075	7.6450	9.2825	7.4425

Table I
(*Continued*)

60 Days	Species	Salt Concentration (%)			
		10 ^{O*}	20 ^{O}	10 ^{F**}	20 ^{F}
		$\bar{x}$			
Acidity (%, lactic acid)	*C. spinosa*	0.7500 C	0.6900 D	0.37000 G	0.25500 H
	C. ovata	1.0725 A	0.9750 B	0.63000 E	0.43250 F
pH	*C. spinosa*	4.4050 E	4.6500 C	3.9100 F	4.9050 A
	C. ovata	4.5550 D	4.6300 C	3.6450 G	4.7650 B
Salt (%)	*C. spinosa*	8.307	17.267	7.903	17.153
	C. ovata	8.545	17.817	7.932	17.045
Lactic Acid Bacteria (CFU/ml) x 10^4	*C. spinosa*	—	—	29.750	—
	C. ovata	—	—	48.750	—
Total Bacteria (CFU/ml) x 10^4	*C. spinosa*	1.0000 b	—	0.5000 c	—
	C. ovata	—	—	1.5000 a	—
Coliform Bacteria (CFU/ml) x 10^4	*C. spinosa*	1.000 C	0.250 C	0.750 C	—
	C. ovata	63.500 A	17.750 B	4.750 BC	8.500 BC
Yeasts-Moulds (CFU/ml) x 10^4	*C. spinosa*	—	—	—	—
	C. ovata	—	—	—	—
Firmness (kg/cm^2)	*C. spinosa*	6.8700	8.0025	8.1375	9.6400
	C. ovata	7.3025	6.7550	8.5100	7.1250
90 Days					
		$\bar{x}$			
Acidity (%, lactic acid)	*C. spinosa*	0.7800 C	0.7150 D	0.47250 F	0.27300 H
	C. ovata	1.0450 A	0.9850 B	0.68750 E	0.44300 G
pH	*C. spinosa*	4.4050 D	4.5950 BC	3.9250 E	4.5950 BC
	C. ovata	4.4400 D	4.5400 C	3.7100 F	4.5400 C
Salt (%)	*C. spinosa*	8.025 E	17.378 A	7.965 E	17.087 A
	C. ovata	8.240 D	17.550 A	7.945 E	17.001 A
Lactic Acid Bacteria (CFU/ml) x 10^4	*C. spinosa*	—	—	18.2500 A	—
	C. ovata	—	—	1.7500 B	—
Total Bacteria (CFU/ml) x 10^4	*C. spinosa*	13.00 BC	5.750 C	25.750 B	5.750 C
	C. ovata	170.250 A	26.000 B	18.250 BC	26.000 B
Coliform Bacteria (CFU/ml) x 10^4	*C. spinosa*	0.750 C	—	—	—
	C. ovata	97.500 A	13.250 B	2.000 C	13.250 B
Yeasts-Moulds (CFU/ml) x 10^4	*C. spinosa*	1.0000 b	—	0.5000 c	—
	C. ovata	—	—	0.5000 a	—
Firmness (kg/cm^2)	*C. spinosa*	6.8700	8.0025	8.1375	8.0025
	C. ovata	7.3025	6.7550	8.5100	6.7550

Table I
(*Continued*)

180 Days	Species	Salt Concentration (%)			
		10 O*	20 O	10 F**	20 F
		$\bar{x}$			
Acidity (%, lactic acid)	*C. spinosa*	0.7850 C	0.6975 D	0.45500 F	0.30500 G
	C. ovata	1.0177 A	0.9950 B	0.67750 E	0.46000 F
pH	*C. spinosa*	4.4100 D	4.5850 C	3.9850 E	4.7850 A
	C. ovata	4.5450 C	4.5850 C	3.7150 F	4.6900 B
Salt (%)	*C. spinosa*	7.985	17.263	8.012	17.065
	C. ovata	8.285	17.670	7.910	17.072
Lactic Acid Bacteria (CFU/ml) x 10^4	*C. spinosa*	—	—	16.7500 A	—
	C. ovata	—	—	0.7500 B	—
Total Bacteria (CFU/ml) x 10^4	*C. spinosa*	6.500 CD	2.750 D	14.000 C	5.750 CD
	C. ovata	81.750 A	27.750 B	8.000 CD	12.00 CD
Coliform Bacteria (CFU/ml) x 10^4	*C. spinosa*	0.500 c	—	—	—
	C. ovata	32.500 a	8.500 b	1.250 c	7.000 bc
Yeasts-Moulds (CFU/ml) x 10^4	*C. spinosa*	—	—	—	—
	C. ovata	—	—	—	—
Firmness (kg/cm^2)	*C. spinosa*	7.1700 C	8.2500 B	7.9925 BC	8.5975 A
	C. ovata	7.4475 BC	7.3925 C	8.3025 A	6.1625 D

*O Old brine
**F Fresh brine
*** Differences among means indicated with majuscules are significant in $P < 0.01$
**** Differences among means indicated with minuscules are significant in $P < 0.05$
***** No growth

LAB growth in 10 % fresh brine during storage indicated available still reducing sugars. LAB were not found in old brines with the same salt concentration, probably due to soluble inhibitory substances of buds.

As a result, the product quality was similarly kept with 10 % and 20 % old or fresh brines. During storage in fresh brine, sediment and off-flavour were not observed for both species. Fermented products can be stored in brine containing at least 10 % salt.

Decreasing of off-flavors preventing of sedimentation, and desirable firmness of buds suggested that fresh brine have to use for long-term storage of pickled capers. Alvarruiz *et al.,* (1990) also reported that salt concentration should not be below 10 % for firmness and color in capers storage. They indicated, otherwise, some off-flavor and/or softening defects. Our results were generally similar to literature findings, with minor differences from different raw materials and process parameters.

4. CONCLUSIONS

Since kept of bud color, no sediment, rapidly reached bottom of buds, removing of undesirable odor in old brine and decreased microbial amounts, the fresh brine containing at least 10 % salt should be suggested for storage of pickled capers.

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