EFFECT OF TECHNOLOGICAL TREATMENTS ON TOTAL PUNGENCY, BROWNING AND TOTAL BACTERIAL COUNT IN NEW GENOTYPES OF GARLIC

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Abstract

The possibility of producing new untraditional garlic juice prepared from different newly clonal genotype of Spanish garlic cultivars (Kaha 211, 221 and 341) was tried. Environmental adaptation, chemical and physical properties for these new genotypes as well as specified properties of bulbing and yield quality were considered. Addition of different natural anti-browning agents as well as retained sulfur compounds were also concerned to prevent browning and preserved pungency. The effect of storage at ambient temperature (25±5°C) for 60 days was investigated. Garlic juice (genotype Kaha 211 and 341) had the lowest amount of total acidity when preserved in solution (0.3% cystein + 0.3% citric acid + 0.1% ascorbic acid) than the other treatments. Total pungency was concentrated in garlic juice (genotype Kaha 221) when preserved in the same solution. This treatment could protect the pungency of garlic juice before and after storage up to 60 days. Garlic juice (genotype Kaha 211) preserved with solution (1.0% NaCl, 0.5% citric acid, 2.0% soybean oil and 0.1% cystein), had a good color index compared with the other treatments. Meanwhile, garlic juice (genotype, Kaha 341) preserved in solution (0.3% cysteine + 0.3% citric acid + 0.1 ascorbic acid) retained a sharp clearly juice. Any colony forming unit of either total bacterial count or fungi were not detected during 60 days of storage especially in genotypes Kaha 211 and 221.

The new clonal genotypes (Kaha 211, 221 and 341) of Spanish garlic cultivars could be used to produce a good quality of garlic juices and added values if compared with other old varieties. So, the research recommend and encourage these new genotypes for cultivating in Egypt and may be especially, used for exportation.

INTRODUCTION

Discoloration of ground garlic (greening browning) is considered to be one of the major problems for distributing or further processing of garlic. Several additives have been reported by Kim *et al.*, (1999) to prevent browning during processing such as cystein, ascorbic acid, sodium sulfite and sodium metabisulfite. Physiological and bio-

chemical factors affecting the browning of garlic after processing were previously investigated by Bae and Lee (1990). They concluded that the addition of citric acid prevented browning reaction and reduced pH values of garlic juice from 6.2 to a value ranging between 4.0 to 5.0; while soybean oil treatment gave a high pH value of garlic juice with a little greening. Meanwhile, Park *et al.*, (1998) stated that treated garlic with 1.0% or 2.0% ascorbic acid or citric acid as well as the use of 0.1% or 0.2% allyl isothiocyanate could effectively retard browning in garlic samples. Sun *et al.*, (1995) mentioned that best results were obtained when using 0.1% $CuSO_4$, 0.1% cystein and 2.5% NaCl to completely deodorized garlic puree for additives in food processing. Bae and Kim (1998) studied the storage stability of concentrated garlic juice prepared by the following three methods : heating at 90°C or using a rotary evaporator at 45°C or by freezing at -50°C until the volume was reduced to 70% of the original value. The obtained concentrated garlic juices were kept at 4 or 25°C for 60 days and changes in level of bacteria and color were monitored every 10 days. The frozen technique seems to be the best method for preparing the concentrated garlic juice with a very sharp white color. Yao and Zz (1997) improved the garlic juice yield by zymolysis (0.3% pectase or cellulose treatment). As a result of such aforementioned treatment the garlic juice had a longer storage life at 4-10°C. On the other hand, the main pungent component of raw garlic was attributed to the alk(en)yl thiosulfinates (mainly allicin) generated by the action of allinase which is act vated on cutting or splitting of garlic clove, on alk(en)yl cystein sulfoxides (mainly allyl cystein sulfoxide or alliin) (Stoll and Seebeck, 1951 and Block, 1992).

Hoon *et al.*, (1999) studied the effect of processing treatments, (crushing, boiling and microwave) on major functional components of garlic. Their results showed that pyruvic acid (pungency) content was at the lowest level with boiling and microwave treatments. On the other hand, Sharma and Nath (1991) stated that pyruvic acid expressed on the basis of total soluble solids (TSS) and they changed their relative pungency rating based on pyruvic acid content. They also added that during processing only 2.8-13.2% of the original content was retained in the product due to thermal or other degradative changes in pungency compounds such as volatilization or due to both these factors.

Thus, this study is an attempt to utilize the excess quantities of garlic grown in Egypt by investigating economically the possibility of producing new and untraditional products for consuming of garlic. With this view in concern, production of garlic juice having both high quality and palatability among different consumers was tried. The aim is also extended to study the factors which enable garlic juice to be stored for the

longest possible period without any undesirable changes in its main chemical and physical properties as a way to enhance exportation.

MATERIALS AND METHODS

A- Material :

Newly released clonal genotypes of garlic "*Allium sativum* L." and their chemical constituents were investigated. The work started since five years with several genotypes of Spanish garlic (*Allium sativum* L). Although in time there were three groups selected and classified in the following Kaha 211, Kaha 221, Kaha 341, three new breeding genotypes derived from selection program by Asfour through 2001-2002 breeding program in Horticultural Research Institute. The selected genotypes took place regarding the phynotypical and chemical characteristics. Width and size of bulb, number and weight of gloves and shape index of bulb were also considered which were measured as length bulbing / diameter.

The characteristics of plants included plant dry weight of bulb, glove dry weight and chemical constituents of the bulb and gloves. The different genotypes of the mentioned groups were tested for two seasons in Kaha experiment farm in Hort. Res. Inst., i.e. 2001 and 2002.

The improved genotypes became stable in their phynotypical and chemical characteristics. The genotypes of the three groups showed superiority in phynotypical characteristics (Table, 1). Chemical constituents were carried out for the different genotypes in different groups at the Central Lab of Hort. Res. Inst. In 2001 and 2002 seasons. The selected genotypes from the different groups were evaluated.

Processing :

The cloves were separated and peeled, washed, crushed in a Warring blender for juice extraction. After filtration, the garlic juice was mixed with solution containing 1.0% NaCl as control sample (solution A). The second treatment (solution B) was prepared from 1.0% NaCl; 0.5% citric acid; 2.0% soybean oil, with antioxidants (0.1% cystein). The third treatment (solution C) was blended by mixing 0.3% cystein + 0.3% citric acid + 0.1% ascorbic acid (antioxidant). All of the investigated garlic juices were packed into sterilized and dried glass jars, pasteurized at 85°C for 5 min., and stored at 25±5°C.

Table (1) Phynotypical characteristics of three garlic genotypes

Genotypes	Plant weight fresh in gram		Plant weight dry in gram		Bulb weight dry in gram		Bulbing rate		Number of cloves per bulb		Shap index (x3)	
	X1	X2	X1	X2	X1	X2	X1	X2	X1	X2	X1	X2
Genotype 211	27.01	28.00	21.06	24.03	19.32	20.20	0.19	0.19	11.51	11.33	0.49	0.49
Genotype 221	37.40	38.25	30.5	31.56	23.20	24.00	0.17	0.17	10.21	11.57	0.59	0.60
Genotype 341	38.17	38.36	32.15	32.22	23.61	23.93	0.17	0.18	8.95	10.04	0.59	0.59
LSD	4.47	2.91	0.79	0.52	0.24	0.31	0.00	0.00	2.65	0.75	0.00	0.00

X1 → First Season

X2 → Second Season

X3 → (L/D) : it measured as $\frac{\text{Length}}{\text{Diameter}}$ of bulbing (cm)

B- Analytical methods:

Total soluble solids (TSS), pH value and titratable acidity were determined according to A.O.A.C. (1990). Color index was given as (O.D) and determined by Hendel *et al.*, (1950); i.e. $E^{5\%}_{1cm}$ at 390 nm, refers to the optical density of an extract prepared with 5 grams of material per 100ml of solvent, with transmittancy in a 1-cm cell at 390 nm. Total pungency (µmol pyruvate acid/ gram fresh weight sample) of the investigated garlic juices was evaluated according to the method performed by Wall and Corgan (1992). Total plate counts were carried out by applying the method of Smith and Townsend (1999). Samples were prepared to determine total pungency, degree of browning and microbiological assay periodically every 10 days till the end of storage period (60 days at 25±5°C).

RESULTS AND DISCUSSION

During two years; work was concentrated in putrification and stability of the genotypes of different garlic groups. The origin before selection are marked as standard Kaha 211, 221 and 341 since it is of important to compare the selected genotypes with standard to show the difference in their constituents.

Data in Table (2) showed that garlic treated with solution (C) in three genotype increased pH value up to 60 days (3.0-4.6) of storage. This increment could be attributed to the slight decrease in citric acid concentration to 0.3% in this treatment. These results were nearly similar to those obtained by Bae and Lee (1990). Titratable acidity that calculated on fresh weight basis decreased with increasing pH values as well as with storage period up to 60 days. The results showed also that garlic juice genotypes (Kaha 211 and 341) had the lowest amount of total acidity in case of using treatment (C) than the other treatments. These results were in agreement with those obtained by Radwan *et al.*, (1998). They stated that the loss in total acidity might be attributed to the non-enzymatic reactions, and also the decrease in acidity during storage could be attributed to some oxidation of constituent ascorbic acid as also reported by Abd El-Ghani (1992). On the other hand, the data obtained by Felming *et al.*, (1983) indicated that the slight increase in total acidity was observed during storage and that has been quite common in most cultivars of garlic products and is not related to microbial growth. From the same (Table, 2) total soluble solids (TSS) was found to be the similar in the control samples of different garlic juice, whereas, it was decreased in case of genotype (Kaha 211) and (Kaha 221) which treated by solution (C). This

Table (2): Changes in selected physicochemical characteristics of the tested garlic juices (genotypes) during storage for 60 days at 25±5oC

Tested parameters	storage period (days)	Garlic genotypes								
		Kaha 211			Kaha 221			Kaha 341		
		A	B	C	A	B	C	A	B	C
PH	0	3.7	3.0	3.4	3.9	3.2	3.2	4.3	2.7	3.0
	30	3.7	3.1	4.4	3.9	3.4	4.0	4.3	2.9	3.8
	60	3.8	3.2	4.6	4.0	3.6	4.3	4.9	3.1	4.1
Titratable Acidity % (F.W)	0	1.19	0.902	0.403	1.07	1.114	1.19	1.03	1.229	0.499
	30	1.08	0.801	0.307	1.03	1.00	1.00	1.00	1.113	0.408
	60	1.00	0.631	0.300	1.00	0.931	0.931	1.00	0.961	0.400
TSS %	0	10.00	7.00	5.00	10.00	8.0	5.6	10.00	8.7	6.0
	30	10.00	7.00	5.00	10.00	8.0	5.6	10.00	8.9	6.1
	60	10.00	7.00	5.00	10.00	8.1	5.5	10.00	8.9	6.1

A : Treatment with 1.0% NaCl (control)

B : Treatment with 1.0% NaCl, 0.5% citric acid, 2.0% soybean oil and 0.1% cystein (antioxidant)

C : Treatment with 0.3% cystein, 0.3% citric acid, 0.1% ascorbic acid (antioxidant)

F.W : Fresh weight

may be due to that the later treatment was free from sodium chloride and soybean oil. All genotypes appear stability for total solub e solids during storage for 60 days at 25°C.

Total pungency calculated as µmol/g fresh weight increased in garlic juice (genotype 221) preserved in solution (C) (from 9.41 in control sample up to 11.60 µmol/g fresh weight). This treatment could protect the loss of pungency level in garlic juice during storage period up to 60 days as shown in Table (3). Results could reflect that genotype Kaha 221 had a good genotype which affected by the increase of cystein content in this treatment to 0.3% instead of 0.1% in the other treatments. The same treatment (solution C) of genotype Kaha 211 recorded lower value of pungency (7.9 µmol/1g fresh weight) than that of the other two genotypes under experiments (7.00-11.60 and 9.36 µmol/g F.W). Results could reflect that pungency may changes in different genotypes that preserved in different solutions, and packed in glass jars. These results were nearly similar to those stated by Stoll and Seebeck, 1951, and Block, 1992).

In garlic juice (Kaha 211) preserved with solution (B), the increasing percentage of degree of browning recorded a very low percentage when compared with the same genotype preserved with control sample (A) and solution (C) as shown in Table (4). Subsequently, garlic genotype (Kaha 211) preserved with solution (B) had a good color index compared with the others. This may be due to the presence of citric acid (0.5%) that acting as anti-browning reaction leading to high quality of genotype (Kaha 211). These results coincide with those obtained by Bae and Lee (1990). Meanwhile, the browning reaction as presented in Table (4) showed that genotype (Kaha 341) preserved in solution (C) had a good color index compared with the other samples preserved in different solutions (B and A).

Table (5) showed the microbiological evaluation for different genotypes preserved in different solutions. The genotypes (Kaha 211) and (Kaha 341) were free from any colony forming unit per gram (CFU/g) during storage for 60 days at 25°C. This might be due to thermal treatment that acheived during processing and the antimicrobial effect of garlic buds and their functional compounds as recorded by Sasaki *et al.*, (1999).

Table (3): Effect of varieties, processing and period of storage on total pungency (µmol/g fresh weight) of the tested garlic juice

Storage period days	Garlic genotypes								
	Kaha 211			Kaha 221			Kaha 341		
	A	B	C	A	B	C	A	B	C
0	9.66	9.84	8.09	9.58	8.36	11.69	9.83	9.92	9.33
10	9.65	9.83	8.00	9.51	8.35	11.65	9.80	9.18	9.33
20	9.63	9.83	7.98	9.50	8.33	11.63	9.76	9.00	9.33
30	9.62	9.82	7.96	9.46	8.32	11.62	9.72	8.93	9.32
40	9.61	9.81	7.95	9.44	8.31	11.61	9.70	8.70	9.31
50	9.61	9.80	7.93	9.43	8.30	11.60	9.66	8.60	9.31
60	9.60	9.80	7.90	9.41	8.30	11.60	9.63	8.00	9.30

A : Treatment with 1.0% NaCl (control)

B : Treatment with 1.0% NaCl, 0.5% citric acid, 2.0% soybean oil and 0.1% cystein (antioxidant)

C : Treatment with 0.3% cystein, 0.3% citric acid, 0.1% ascorbic acid (antioxidant)

Table (4): Effect of varieties, processing and period of storage on browning level of garlic juice genotypes

Garlic genotypes	Treatment	Browning index	Storage periods (days)						
			0	10	20	30	40	50	60
Kaha 211	A	%	---	8.40	15.27	30.15	46.18	53.44	74.05
		Abs	0.262	0.284	0.302	0.341	0.383	0.402	0.456
	B	%	---	---	1.65	2.48	3.31	3.31	3.72
		Abs	0.242	0.242	0.246	0.248	0.250	0.250	0.251
	C	%	---	8.04	9 82	16.07	18.75	20.53	23.21
		Abs	0.112	0.121	0.123	0.130	0.133	0.135	0.138
Kaha 221	A	%	---	7.52	15.41	28.9	43.60	52.63	72.18
		Abs	0.266	0.286	0.307	0.343	0.382	0.406	0.456
	B	%	---	6.69	9.82	9.82	11.16	16.07	24.11
		Abs	0.224	0.239	0.246	0.246	0.249	0.260	0.278
	C	%	---	23.50	25.70	29.40	34.50	38.90	49.30
		Abs	0.136	0.168	0.171	0.176	0.183	0.189	0.203
Kaha 341	A	%	---	7.19	15.53	28.79	45.08	54.17	73.11
		Abs	0.264	0.283	0.305	0.340	0.383	0.407	0.457
	B	%	---	5.05	9.17	19.27	25.20	31.20	32.50
		Abs	0.218	0.229	0.238	0.260	0.273	0.286	0.289
	C	%	---	1.83	3.67	3.67	4.59	4.59	6.42
		Abs	0.109	0.111	0.113	0.113	0.114	0.114	0.116

A : Treatment with 1.0% NaCl (control)

B : Treatment with 1.0% NaCl, 0.5% citric acid, 2.0% soybean oil and 0.1% cystein (antioxidant)

C : Treatment with 0.3% cystein, 0.3% citric acid, 0.1% ascorbic acid (antioxidant)

Table (5) : Effect of storage for 60 days at different garlic juice genotypes as well as treatments on total viable bacterial count (TVC)

Time Days	Garlic juice (genotypes) treatments								
	Kaha 211			Kaha 221			Kaha 341		
	A	B	C	A	B	C	A	B	C
0	2 *	N.D	2	2 *	7	3	2 *	N.D	2
10	2	N.D	2	2	7	3	2	N.D	3
20	3	N.D	3	3	7	3	3	N.D	3
30	3	N.D	3	3	8	4	3	N.D	4
40	3	N.D	4	3	8	4	3	N.D	4
50	4	N.D	4	4	8	5	4	N.D	5
60	4	N.D	4	4	8	5	4	N.D	5

A : Treatment with 1.0% NaCl (control)

B : Treatment with 1% NaCl, 0.5% citric acid, 2.0% soybean oil and 0.1% cystein (antioxidant)

C : Treatment with 0.3% cystein, 0.3% citric acid, 0.1% ascorbic acid (antioxidant)

* Colony forming units/gram (CFU/g) _ 10

N.D : Not detected

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تأثير المعاملات التكنولوجية علي المواد الحريفة والتلون والعد البكتيري في عصير بعض السلالات الجديدة من الثوم

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أجريت هذه الدراسة لتحديد مدي إمكانية الحصول علي منتج غير تقليدي من عصير الثوم مصنع من (سلالات حديثة مستنبطة من الثوم الأسباني بقسم بحوث الخضر خضرية التكاثر بمعهد بحوث البساتين) حيث تم تصنيعه بإضافة مواد طبيعية تمنع التلون وتحافظ علي المركبات الحريفة. حيث تم دراسة تأثير التخزين علي درجة ٢٥°م لمدة ٦٠ يوماً علي محتوي العصير الناتج من المواد الحريفة والتلون . وقد دلت النتائج المتحصل عليها من هذه الدراسة أن السلالات الأولي (قها ٢١١) والثالثة (قها ٣٤١) تحتوي علي أقل النسب من الحموضة الكلية وذلك عند الحفظ في محلول (٠,٣٪ سيستيئين + ٠,٣٪ حمض ستريك + ٠,١٪ حمض أسكوربيك) بالمقارنة بباقي المعاملات. وكذلك أوضحت النتائج أن الحرافة الكلية تزيد في السلالة الثانية (قها ٢٢١) من عصير الثوم المعامل بنفس المعاملة السابقة فهذه المعاملة ثبت أنها تحافظ فعلاً علي المواد الحريفة في عصير الثوم الناتج سواء أثناء التصنيع أو بعد التخزين لمدة ٦٠ يوماً. ومن ناحية أخري إحتفظت السلالة الأولي (قها ٢١١) في محلول (١٪ ملح طعام + ٠,٥٪ حمض ستريك + ٢٪ زيت صويا + ٠,١٪ سيستيئين) باللون المرغوب للعصير مقارنة بباقي المعاملات وكذلك إحتفظت السلالة الثالثة (قها ٣٤١) بخصائص جودة العصير وذلك عند المعاملة بالمحلول (٠,٣٪ سيستيئين + ٠,٣٪ حمض ستريك + ٠,١٪ حمض أسكوربيك).

ومن ناحية أخري أوضحت النتائج الخاصة بالعد الكلي للبكتيريا والفطر بالتحاليل الدورية أنه لا توجد نموات علي الإطلاق حتي ٦٠ يوم من التجربة في جميع معاملات عصير الثوم الناتج خاصة في سلالة قها ٢١١ و قها ٣٤١ . ومن واقع هذه الدراسة يمكن إستخدام السلالات الثلاثة موضوع الدراسة في مجال التصنيع الغذائي لإنتاج عصائر الثوم ذات صفات الجودة العالية والتي تحقق عائد أعلي عن مثيلاتها من الأصناف القديمة ولذلك نوصي بالتوسع في نشر هذه السلالات لإستخدامها في التصنيع الغذائي.