

PRODUCTION AND EVALUATION OF NONTRADITIONAL PRODUCTS FROM LEMON GRASS

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Abstract

This study was carried out to produce products having high nutritional value from lemon grass with valencia orange, Egyptian lime and cantaloupe juices available all the year besides studying the factors affecting on quality of products after processing and during storage. Blends were prepared from lemon grass extract with orange, lime and cantaloupe juices at a ratio of 1:1, 2:1 and 3:1(wt:wt), respectively .Results indicate that total carbohydrates, fat, ash, total phenols and ascorbic acid contents of lemon grass leaves were 75.73, 4.15, 9.47, 3.76% and 175.11 mg/100g (on dry weight basis) ,respectively. Results illustrate that total soluble solids (T.S.S.) of blends ranged from 15 -15.3%, total sugars from 79.51 to 88.86%, ash content (1.83-2.56%), total phenols content (0.410 -0.812%) and ascorbic acid content (23.02-152.4mg/100g) on dry weight basis. Results show that statistical analyses for sensory evaluation of nectars were accepted for orange juice at a ratio of 2:1 and lemon grass extract: lime juice at a ratio of 3:1.The chemical composition of products was slightly affected by storage, while statistical analyses for sensory evaluation of nectars ascertained that they were accepted till 9 months of storage at room temperature. Also, results show that total bacterial count was less than 10 cfu/gfor nectars during storage.

Key words : lemon grass, extract, juice ,nectar, storage
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INTRODUCTION

Lemon grass (*Cymbopogon citrates*) of the *poaceae* family is cultivated in tropical and semi-tropical areas (*Ravinder et al., 2010*). It is one of aromatic herb of interest, widely used in tropical and subtropical countries in human foods and tea preparation and it contains essential oils which are used in perfume and pharmaceutical industries(*Koshima et ai., 2003 and wanapat et al ., 2008*).

This species commonly cultivated for the fine fragrance of the leaves which are often used for flavoring custard. When fresh and young, leaves are consumed in salads and are used to prepare traditional meat recipes. The white center of the leaves is also used to impart a flavorto curries. The tea made from this grass is considered a whole some and refreshing beverage that is much appreciated and largely consumed in

North Africa (*Khadri et al., 2010*) as a substitute for tea, due to its pleasant aroma and taste.

Also, *Asaolu et al., (2009)* showed that *Cymbopogon citrates* is a plant of considerable economic importance which forms the bedrock farming systems in many countries where they are cultivated for commercial purpose.

Olotade (2009) reported that crude fiber, fat and carbohydrate contents of dried *Cymbopogon citrates* leaves were 27.72, 1.25 and 38.44 % (on fresh weight basis), respectively. Total of 19 constituents representing 95.47% of the essential oil were identified : piperitone(72.44%), elemol(9.43%), α -eudesmol(4.34%), limonene(2.45%) and β - (1.26%) were the main components comprising 88.92% of the oil. The antimicrobial results show that the essential oil of *Cymbopogon citrates* strongly inhibited the growth of the test bacteria (Selim, 2011).

García et al., (2001) and *Dyabet et al., (2010)* reported that blending treatments of pulps or juices of fruits and vegetables with other pulps or juices from fruits and vegetables led to raising its acceptability for consumer and increasing in total phenolic compounds and antioxidant activity.

The objectives of this study were the preparation and evaluation of nectar formulas which contain lemon grass with different juices.

MATERIALS AND METHODS

Materials:-

Lemon grass (*Cymbopogon citrates*) was obtained from the Horticultural Research Inst., Agric., Res. Center, Giza, Egypt. Valencia oranges (*Citrus sinensis*), called summer oranges, Egyptian lime (*Citrus aurantifolia*) and Galia cantaloupe (*Cucumis melo L.*) were purchased from local market. Sucrose was obtained from Sugar and Integrated Industries Co., Egypt.

Methods:-

Processing methods:-

Preparation of juices and lemon grass extract

Orange and lime juices

Fruits were sorted, washed, cut into halves, pressed by hydraulic laboratory press, then the resultant juices were strained through anylon sieve.

Cantaloupe juice

Cantaloupe vegetables were sorted washed peeled, divided into two equal portions to remove the seeds. Water was added to the portions at a ratio 1:2 (vol: wt) and mixed with electric pulper, then screened through a nylon sieve.

Lemon grass extract

Lemon grass leaves were extracted with a ratio of lemon grass to water 1:4(wt: vol) and boiled in reflecting condenser for 30 min., then the mixtures were filtered through a nylon sieve.

Preparation of nectar formulas from lemon grass extract with different juices

Lemon grass extract was mixed with juices at different ratios as follows: -

Control (lemon grass extract without the addition of juices).

Treatment (1) Lemon grass extract: valencia orange juice at a ratio of 1:1(wt: wt).

Treatment (2) Lemon grass extract: valencia orange juice at a ratio of 2:1(wt: wt).

Treatment (3) Lemon grass extract: valencia orange juice at a ratio of 3:1(wt: wt).

Treatment (4) Lemon grass extract: lime juice at a ratio of 1:1(wt: wt).

Treatment (5) Lemon grass extract: lime juice at a ratio of 2:1(wt: wt).

Treatment (6) Lemon grass extract: lime juice at a ratio of 3:1(wt: wt).

Treatment (7) Lemon grass extract: cantaloupe juice at a ratio of 1:1(wt: wt).

Treatment (8) Lemon grass extract: cantaloupe juice at a ratio of 2:1(wt: wt).

Treatment (9) Lemon grass extract: cantaloupe juice at a ratio of 3:1(wt: wt).

Nectar formulas and control treatments raised total soluble solids (T.S.S) to ≥ 15 % by sucrose. Then the nectars were pasteurized at 85 °C for 10 min, cooled and stored at room temperature for analysis.

Analytical methods:-

Chemical analysis

Moisture content, pH value total soluble solids (T.S.S.), total titratable acidity, reducing, non-reducing and total sugars, ash, crude fiber, fat, total phenols and total carbohydrates contents were determined according to the procedure described in the A.O.A.C. (2005). Chlorophyll a, b and total carotenoids were determined according to Askar and Treptow (1993)

Microbiological evaluation

Total bacterial counts as well as yeast and mould counts were determined according to the method described by APHA (1992).

Sensory evaluation of samples:

The nectars were sensory evaluated according to the method described by García et al., (2001).

Statistical analysis

The obtained data of sensory evaluation of nectars were statistically analyzed according to ANOVA procedure of the SPSS statistical package (SPSS, 1990).

RESULTS AND DISCUSSION

Physical and chemical constituents of fresh lemon grass leaves

Results in table (1) show that moisture content, TSS, and pH value of lemon grass leaves were 80.47%, 4.3% and 5.76%, respectively. Results in table (1) indicate that total carbohydrates, crude fiber, fat and ash contents were 75.73, 52.02, 4.15 and 9.47% on dry weight basis. These results are in agreement with those reported by Naguib (2002) and Omer et al., (2010). Also, results in the same table illustrate that total phenols of fresh leaf lemon grass was 3.76 % on dry weight basis. Yoo et al., (2008) reported that total phenols of lemon grass were 662mg GAE/100 g (gallic acid equivalents per 100g of fresh herb).

Table 1. Physical and chemical constituents of fresh lemon grass leaves.

properties	Value
Moisture content %	80.47
TSS %	4.30
pH value	5.76
Total acidity* (as citric acid) %	0.732
Reducing sugars* %	6.91
Non-reducing sugars* %	2.10
Total sugars* %	9.01
Crude fiber* %	52.02
Total carbohydrates* %	75.73
Fat* %	4.15
Ash* %	9.47
Total phenols* %	3.76
Chlorophyll *(a) mg/100g	19.20
Chlorophyll* (b) mg/100g	10.54
Total carotenoides* mg/100g	1.43
Ascorbic acid* mg/100g	175.11

* On dry weight basis

Refaat and Balbaa (2001) and Mirza et al., (2003) illustrate that percentage of the different components in lemon grass differed with fertilization and environmental conditions prevailing during growth.

Physical and chemical constituents of juices and lemon grass extract

Physical and chemical properties of oranges, lime, cantaloupe juices as well as fresh lemon grass extract are presented in Table (2). The moisture contents of

different juices ranged from 87.00 to 98.11% .From the same table it could be noticed that the highest total acidity of lime juice followed by other juices while, ascorbic acid content of orange juice was higher than that of other ones. From the same results in Table (2) it could be noticed that ash and total phenols content were the highest in lemon grass extract from other juices. Guimarães, *et. al.* (2010) found that reducing sugars of orange and lime juices were 63.07 and 22.43 mg/g extract, phenolics 12.41 and 11.17 mgGAE/g extract, carotenoids 0.8 and 0.6 ug/g extract and ascorbic acid 523.89 and 417.44 ug/g extract, respectively .Total sugars in lemon grass extract were the lowest compared to other juices. These results are in agreement with those found by Kelebek, *et. al.* (2009) and Solval, *et al.*,(2012).

Table 2. Some physical and chemical constituents of juices and lemon grass.

Juices	Valencia orange juice	Lime juice	Cantaloupe juice	Lemon grass extract
Moisture %	87.00	92.55	92.90	98.11
TSS %	12.4	7.00	6.30	1.20
pH value	4.00	2.66	6.18	5.85
Total acidity*(ascitricacid)%	3.06	29.58	0.123	1.85
Reducing sugars*%	37.47	12.89	41.48	23.80
Non-reducing sugars*%	46.40	19.41	17.77	5.31
Total sugars*%	83.87	32.30	59.25	29.11
Ash*%	3.51	4.26	7.03	15.34
Total phenols*%	0.285	0.281	0.148	6.87
Total carotenoids* mg/100g	5.21	0.769	4.44	2.64
Ascorbic acid* mg/100g	425.43	308.99	63.95	224.86

*On dry weight basis.

Physical and chemical constituents of nectar formulas.

The prepared nectar formulas reached up to 15 %T.S.S .according to the Egyptian standards(1992). Results in Table (3) indicate that T.S.S value and moisture contents of the different nectars ranged from 15 to 15.30% and from 83.76 to 84.61%, respectively. Results in Table (3) indicate that increasing lemon grass extract to different juices at a ratio from 1: 1 to 3: 1 gradually reduce total acidity content of the prepared nectars. Results in table (3) illustrated that total sugars of nectars ranged from 79.51 to 91.25% (on dry weight basis).

Table 3. physical and chemical constituents of nectars formulas.

Nectars properties	Cont.	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉
Moisture %	84.41	84.45	84.61	84.37	84.33	84.22	84.42	83.76	83.78	83.85
TSS %	15.0	15.1	15.0	15.3	15.0	15.2	15.1	15.1	15.2	15.3
pH value	5.83	4.19	4.20	4.35	2.85	2.95	3.13	5.95	6.05	6.10
Total acidity*(as citric acid)%	0.216	1.30	0.95	0.76	7.88	5.32	4.12	0.134	0.164	0.179
Reducing sugars*%	5.80	20.81	17.04	14.26	12.42	10.98	10.13	15.27	12.65	11.16
Non-reducing sugars*%	85.45	62.28	69.83	74.60	67.09	72.58	75.81	68.14	74.96	77.40
Total sugars*%	91.25	83.09	86.87	88.86	79.51	83.56	85.94	83.41	87.61	88.56
Ash*%	1.79	2.28	2.14	2.05	2.01	1.92	1.83	2.56	2.37	2.22
Total phenols*%	0.71	0.410	0.500	0.570	0.485	0.581	0.812	0.421	0.550	0.621
Total carotenoides* mg/100g	0.28	1.95	1.45	0.97	0.354	0.320	0.345	1.22	0.952	0.791
Ascorbicacid* mg/100g	24.29	152.4	110.9	86.75	86.63	65.30	56..36	23.46	23.39	23.02

*On dry weight basis. Cont. (lemon grass extract without addition of juices)

T₁ (Lemon grass extract: Orange juice, 1:1), T₂ (Lemongrass extract: Orange juice, 2:1), T₃ (Lemongrass extract: Orange juice, 3:1), T₄ (Lemongrass extract: lime juice, 1:1), T₅ (Lemongrass extract: lime juice, 2:1), T₆ (Lemongrass extract: lime juice, 3:1), T₇ (Lemon grass extract: cantaloupe juice, 1:1), T₈ (Lemongrass extract: cantaloupe juice, 2:1), T₉ (Lemon grass extract: cantaloupe juice, 3:1).

On the other hand, results in the same Table (3) shows that, non reducing sugars were higher than that reducing sugars of nectars due to the addition of sucrose to

increase the T.S.S.to 15 %.Ascorbic acid, total phenols and total carotenoides contents are one of the most important parameters to be considered in determining the quality of formulas because it is considered the main factors of antioxidant activity. Results in Table (3) indicate that ascorbic acid and total carotenoides of Valencia orange juice with lemon grass extract were higher than that of other ones due to its high contents of original juice.

Effect of mixing lemon grass extract with different juices on sensory evaluation.

The color, taste, odor and overall acceptability of natural nectars formulas from lemon grass extract without and with Valencia oranges, lime and cantaloupe juices were evaluated. Results in Table (4) indicate that color scores of treatments (T₁, T₂and T₆) were significantly higher than those of other treatments.

Table 4. Mean score values of sensory evaluation of nectar formulas after preparation.

Parameters Treatments	Color	Taste	Odor	overall acceptability
Control	5.3 ^c ±0.66	6.8 ^{bc} ±0.54	8.0 ^a ±0.22	5.5 ^{bc} ±.045
T ₁	9.0 ^a ±0.45	7.8 ^{bc} ±0.63	8.0 ^a ±.41	6.0 ^b ±0.70
T ₂	9.0 ^a ± 0.63	8.8 ^a ±0.12	7.6 ^{ab} ±0.57	9.0 ^a ±0.44
T ₃	5.8 ^c ±0.49	8.2 ^{ab} ±0.13	7.6 ^{ab} ±0.43	5.6 ^{bc} ±0.89
T ₄	5.6 ^c ± 0.94	5.4 ^c ± 0.89	8.0 ^a ± 0.33	5.0 ^{bc} ±0.58
T ₅	7.0 ^b ± 0.71	7.9 ^{bc} ±0.69	7.6 ^{ab} ±0.67	6.0 ^b ±0.70
T ₆	9.2 ^a ±0.73	8.6 ^a ±.59	7.5 ^{ab} ±0.51	8.5 ^a ±0.66
T ₇	7.0 ^b ±0.70	6.0 ^c ±0.72	5.6 ^{bc} ±0.89	5.0 ^{bc} ±0.70
T ₈	6.1 ^{bc} ±0.73	7.0 ^c ±0.58	5.6 ^{b^c} ±0.46	4.4 ^c ±0.54
T ₉	6.0 ^{bc} ±0.68	6.9 ^{bc} ±0.43	4.6 ^c ±0.75	4.2 ^c ±0.82

Means with the same column are not significantly different at 0.05 level of significance.

Cont.(lemon grass extract without addition of juices) ,T₁ (Lemongrass extract: Orange juice, 1:1), T₂ (Lemongrass extract: Orange juice, 2:1),T₃ (Lemongrass extract: Orange juice, 3:1), T₄ (Lemongrass extract: lime juice, 1:1),T₅ (Lemon grass extract: lime juice, 2:1), T₆ (Lemon grass extract: lime juice, 3:1),T₇ (Lemongrass extract:

cantaloupe juice, 1:1), T₈ (Lemon grass extract: cantaloupe juice, 2:2), T₉ (Lemon grass extract: cantaloupe juice, 3:1).

From the same table (4) it could be seen that taste scores of the treatments (T₂ and T₆) were significantly higher than those of other formulas. It is obvious that no significant difference was found in odor of products from lemon grass with lime or orange nectars formulas. Inyang and Abah (1997) reported that blending could lead to the production of delightful and delicious beverages with improved organoleptic quality and a high nutritive value. The high scores in the overall acceptability were found in formulas (T₂ and T₆). It could be concluded that lemon grass with orange juice at a ratio of 2:1 or lemon grass with lime juice at a ratio of 3:1 gave the best record and highest acceptability, thus, these formulas were selected among all studies to follow their quality parameters during storage.

Effect of storage period on physical and chemical constituents of nectar formulas at room temperature.

Results in table (5) show physical and chemical constituents of formulas nectar (T₂ and T₆) during storage. Moisture content of nectar formulas was almost stable during storage periods. Total soluble solids slightly showed a decrease during storage from 0.6 to 1.3% of the initial value. Results in table (5) indicate that total acidity content was accompanied by a gradual and slight decrease from 0.95 to 0.87% of Lemon grass extract: orange juice 2:1 (T₂) and from 4.12 to 3.78% of lemon grass extract: lime juice 3:1 (T₆), respectively. These decrements in total acidity could be attributed mainly to the breakdown of ascorbic acid during storage. Results in table (5) indicate that reducing sugars highly increased during storage periods. This increase of reducing sugars content may be related to the high level of total acidity contents in the products that hydrolyzed the non-reducing sugars during storage.

Also, total sugars slightly decreased during storage. This decrement could be due to reducing sugars reaction with amino acids. Results in Table (5) indicate that ascorbic acid of nectars decreased during storage. These results are in agreement with those found by Klimczak *et al.*, (2007). On the other hand, the rate of ascorbic acid reduction during storage of lemon grass with lime juice was lower than that of nectar with orange juice.

Effect of storage period on microbial counts of nectar formulas at room temperature.

Total bacterial as well as yeast and mold counts were absent after processing till 6 months from storage while, total bacterial counts slightly increased during storage but still lower than 10 cfu/g of all products at the end of storage period.

These results are in accordance with those reported by Chao *and* Young (2000), Ravinder *et al.*, (2010) and Selim (2011) who found that lemon grass essential oil was active against food storage fungi and the inhibition of the growth of food spoilage, food –borne pathogens .

Table 5. physical and chemical constituents of nectar formulas during storage at room temperature.

Nectar formulas	T ₂				T ₆			
	Zero time	3	6	9	Zero time	3	6	9
Moisture %	84.61	84.60	84.69	84.70	84.42	84.45	84.53	84.58
TSS %	15.0	15.0	14.9	14.9	15.1	15.0	14.9	14.9
pH value	4.20	4.25	4.28	4.34	3.13	3.20	3.25	3.30
Total acidity*(as citric acid)%	0.95	0.90	0.88	0.87	4.12	4.08	3.90	3.78
Reducing sugars*%	17.04	20.54	21.79	21.51	10.13	14.91	17.83	19.08
Non-reducing sugars*%	69.83	65.01	63.22	62.75	75.81	70.11	66.45	64.45
Total sugars*%	86.87	85.55	85.01	84.26	85.94	85.02	84.28	83.53
Total phenols*%	0.500	0.452	0.442	0.425	0.812	0.743	0.730	0.715
Total carotenoides* mg/100g	1.45	1.377	1.348	1.305	0.345	0.310	0.293	0.276
Ascorbic acid* mg/100g	110.9	91.38	82.17	77.63	56..36	47.85	45.04	42.22

* On dry weight basis, T₂ (Lemongrass extract: Orange juice, 2:1), T₆ (Lemongrass extract: lime juice, 3:1)

Effect of storage period on sensory evaluation of nectar formulas at room temperature.

Results in Table (6) show that mean scores of sensory evaluation of all products decreased by storage. However, the mean scores of all products were higher than that of 6.95 scores after 9 month of storage at room temperature indicating superior quality.

Hence it could be recommended to produce nectar formulas (lemon grass with orange and lime juices) at a ratio of 2: 1 or 3: 1, respectively to give excellent product.

Table 6. Mean score values of sensory evaluation of nectar formulas during storage at room temperature.

Nectar formulas	T ₂				T ₆			
	Zero Time	3	6	9	Zero time	3	6	9
Color	9.0 ^a ± 0.63	8.04 ^{ab} ±0.54	8.0 ^{ab} ±0.43	7.84 ^{ab} ±0.81	9.2 ^a ±0.73	8.23 ^a ±0.73	8.13 ^{ab} ±0.73	8.01 ^{ab} ±0.73
Taste	8.8 ^a ±0.12	8.31 ^a ±0.42	8.01 ^{ab} ±0.62	7.82 ^b ±0.32	8.6 ^a ±0.59	8.12 ^a ±0.41	7.84 ^{ab} ±0.53	7.65 ^b ±0.72
Odor	7.6 ^{ab} ±0.57	7.13 ^b ±0.77	7.11 ^b ±0.49	7.04 ^b ±0.66	7.5 ^{ab} ±0.51	7.03 ^b ±0.77	7.0 ^b ±0.63	6.95 ^b ±0.89
Overall acceptability	9.0 ^a ±0.44	8.45 ^a ±0.81	8.16 ^{ab} ±0.34	8.06 ^{ab} ±0.52	8.5 ^a ±0.66	8.12 ^a ±0.36	7.93 ^{ab} ±0.52	7.6 ^{ab} ±0.49

Means with the same column are not significantly different at 0.05 level of significance.

T₂ (Lemongrass extract: Orange juice, 2:1), T₆ (Lemon grass extract: lime juice, 3:1)

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إنتاج وتقييم منتجات غير تقليدية من حشيشة الليمون

مصطفى طه محمدى عسوس ، قدرى حامد محمد الوصيف ، جادو بكر احمد جادو

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تهدف الدراسة إلى إنتاج نكتار ذو قيمة غذائية عالية ومتواجد طوال العام ورخيص السعر من مستخلص حشيشة الليمون مع عصائر برتقال الفالانشيا، الليمون المالح المصرى، الكانتلوب بالإضافة إلى دراسة العوامل التي تؤثر على جودة المنتجات الناتجة بعد التصنيع وأثناء التخزين. تم عمل خلطات من مستخلص حشيشة الليمون الى عصائر برتقال الفالانشيا، الليمون المالح المصرى ، الكانتلوب بنسب 1:1 و 1:2 و 1:3 (مستخلص حشيشة الليمون الى العصائر الأخرى) على التوالي .

تحتوى حشيشة الليمون على 4.15، 75.73، 9.47 ، 3.76% و 175.11 ملجم / 100 جم على اساس الوزن الجاف لكل من الكربوهيدرات ،الدهون ،الرماد ،الفينولات الكلية وحمض الاسكوربيك على التوالي.

اظهرت النتائج ان محتوى الخلطات من المواد الصلبة الذائبة 15 - 15.3% وتراوحت السكريات الكلية (79.51- 88.86 %)والرماد (1.83- 2.56 %) والفينولات الكلية (0.410- 0.812%) وحمض الاسكوربيك (23.02 - 152.4 ملجم / 100 جم) على اساس الوزن الجاف .

اوضحت نتائج التحليل الاحصائى للتقييم الحسى للنكتار الناتج ان مسخلص حشيشة الليمون :عصيربرتقال الفالانشيا بنسبة 2 : 1ومستخلص حشيشة الليمون: عصيرالليمون المالح المصرى بنسبة 3:1كانت مقبولة.

تأثر التركيب الكيماوى تأثيراً طفيفاً مع التخزين بينما كان التحليل الاحصائى لنتائج الاختبارات الحسية مقبولة حسيّاً حتى بعد 9 شهور من التخزين. وقد دلت النتائج ايضا على العدد الكلى للبكتريا للنكتار لم يزد عن 10 مستعمرة /جم لكل المنتجات اثناء التخزين .