International Journal of Agricultural Research and Food Production
ISSN: 2536-7331 (Print): 2536-734x (Online)
Volume 4, Number 4, December 2019
http://www.casirmediapublishing.com

QUALITY PROPERTIES AND SHELF LIFE EVALUATION OF BREAD AND COOKIES INCOOPERATED WITH ORGANIC PRESERVATIVE EXTRACTS (ANTI MICROBIAL AND ANTIOXIDANTS) OBTAINED FROM NATURAL SOURCES

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ABSTRACT
Organic extracts containing antimicrobial and antioxidant agents from lemon, tumeric, onion peel and ripe cloves were prepared and used to preserve bread and cookies alongside sodium benzoate chemical preservative, then subjected to sensory property, microbiological and shelf life evaluation at the ambient temperature (28±2°C). Each extract was applied at four (4) concentration levels (0.04, 0.06, 0.08 and 0.10g/100g flour) and sodium benzoate (0.03g/100g flour) as control for bread, doughnut and biscuit samples (all coded). They were stored under ambient conditions, subjected to interval routine inspection, sensory, microbiological assessment, shelf life evaluation and data analysis using standard methods in all cases. The colour, taste, flavour and texture of bread loaf were most retained for five (5) days with 0.06g lemon extract/100g flour, similar to the control without any significant difference ($p \geq 0.05$). Other extracts regardless of their concentration (0.04-010g) were found to retain these sensory attributes for lesser days before onset of mould growth. Also, the sensory attributes (colour, taste and flavour) of doughnut samples were not affected up to 8 days with 0.06g onion peel extract and 0.10g lemon extract /100g flour, while the control sample did not keep more than 5 days in storage. Tumeric and clove extracts, regardless of the concentration (0.04-0.10g) did not preserve doughnut beyond 3 and 6 days respectively. Apparently, extracts of lemon, onion peel and tumeric (0.04-0.010g concentration levels) and control were found to retain the colour, taste and flavour of biscuit for up to 5weeks under ambient storage temperature (28±°C), while clove extract preserved samples had poor colour, taste and flavour ratings regardless of the storage duration. The total plate count (TPC) of bread samples stored up to 5 days with lemon extract ranged from 2.9-4.1x10^{1} cfu/g samples; doughnut with lemon and onion peel extracts kept for 8 days had a range of 5.3 -5.7x10^{1} and biscuit stored for 5 weeks had range, 1.5-3.0 x10^{1} cfu/g sample. However, moulds and coliform were not detected. Although, samples with other extracts with corresponding concentrations that kept for few days as applicable had moulds (1.9-3.6x10^{1} MPN/g sample) which rendered them unsafe for consumption and storage discontinued. Both lemon juice and onion peel extracts are found to be suitable organic antimicrobial /antioxidant agents suitable to replace chemical preservative for bread and cookies (doughnut and biscuit).

Keywords: Organic Preservatives, Fruit/vegetable extracts, Cookies/bread preservation, Antimicrobial agent, Antioxidant.

INTRODUCTION
Cookies refer to fried/baked floury products which resemble intermediate moisture foods. They have short shelf life of few days after which deterioration sets in, including mould invasion, loss of taste, flavor, freshness and become stale. Typical examples include Doughnut, Buns, puff-puff, bread, biscuits. They are widely consumed by all categories of people including children, adult, aged, males and females (Akaka and Okaka, 2008). To extend the shelf life of cookies/bread, preservatives, especially synthetics/ chemical types are applied/ incorporated. In most cases, banned, expired chemical preservatives that are cheap are used by processors to cut corners, even over doses are used to bring about unnecessarily extended shelf life. These practices lead to health risks exposing the

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http://www.casirmediapublishing.com

consumer to danger of toxicity apart from the long run negative effect of cumulative residual chemical preservatives to the body which causes all manners of ailments such as cancer, turmoils kidney/ liver and heart failures (Pecklam, 2006 and WHO, 2009).

These days, consumers tend to avoid chemically preserved foods for health reasons, and therefore there is need for alternative, safe organic preservatives to replace synthetics used in cookies, bread/biscuits. Organic/ natural food additives preservatives are obtained from purely natural sources (plants and animals) and not by chemical reactions. They are usually crude extracts purified/refined for use. Several organic preservative have been extracted, such as from tumeric baobab, lemon and lime (ascorbic acid as antioxidant and nutrient). Rosemary, ripe clove, cinnamon, prune (source of benzoic acid as antimicrobial), onion skin/peel (antioxidant, antimicrobial), rock salt, chile salt petre, cryolite (Sulphur dioxide derivative, K, Ca, as anti mould bacteria), (Annunciata *at al* 2013; Latif *et al* 2005). Organic extracts as food additives have been shown not to constitute any harmful effect, potent and have durable preservation effect on food product, health friendly, cheap, but due to crudeness, they require refining, setting dosages and allowable/ permissible limits, i.e minimum and maximum levels (Bezhall, 2006). Therefore, the major focus and objective of this work was to prepare organic preservative extracts from ripe cloves, onion, tumeric and lemon fruits for cookies (doughnut, biscuits) and bread, evaluate their sensory properties as well as shelf-life under tropical ambient storage conditions.

MATERIALS AND METHODS

Sources of Materials

Cookies/Bread ingredients (wheat flour sugar yeast, milk powder) were purchased from Anyigba central market, Kogi State Nigeria. The organic preservative samples were obtained from different locations which include dripe cloves (Ogbete market, Enugu) onion skin (Kaduna central market, Kaduna State), tumeric (Kacha market Bauchi) lemon fruit (International market, Lokoja, Kogi State).

Organic extract Preparation

Sorted on clove sample was cleaned, ground into powder sieved (180, micron particle size) and packaged into heat sealed low density polyethylene clove powder was quantitatively tested for crude benzoic acid (anti-microbial agent) accioring to method describe (B D H, 2014).Lemon fruit was washed, peeled, juice extracted (pH 2.2) and bottled. Lemon juice was analyzed for ascorbic acid (as anti oxiodant preservative) as described (Onwuka, 2005, Pearson, 2009). Onion peel was washed, dried at (60°C) and reduced into power (180μ) by dry-milling and then packaged (heat sealed high density polyethylene) onion peel powder was divided into 2 parts, one part qualitatively tested for benzoic acid (antimicrobial agent) according to method described (BDH 2014) and second part analysed for antioxidant activity as described (Pearson, 2009). Tumeric was prepared into powder (involved washing, peeling, slicing, drying, dry- milling) and then analyzed for as ascobic acid as antioxiodant (Onwuka, 2005).

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Bread and Cookie Samples Preparation with added Organic Preservative Extracts

Bread loaf was baked with extracts of lemon juice, tumeric, onion peel and clove preservatives separately at 4 concentration levels (0.04,0.06,0.08 and 0.10g per 100g flour, and 0.03g sodium benzoate/ 100 g flour as control chemical preservative) making 5 bread samples per organic preservative (ie 20 experimental bread samples for the 4 different preservatives). Straight dough method was used (Pearson, 2009) and standard bread recipe (57.20% flour, 4.0% sugar, 2.3% shortening, 1.1% salt, 1.7% yeast and 33.7% water). Doughnut and biscuit cookies were similarly preserved as bread, using the 4 different organic extracts as described above.

Standard methods (frying for doughnut and baking for biscuit) and recipes were used (table 1 represents the preservative concentration levels in the products).

Table1: Organic preservatives and concentration levels in bread, doughnut and biscuit products.

Sample and Codes (per 100g flour)

Organic Extract	Concentration Levels		
	Bread	Doughnut	Biscuit
	0.04, 0.06, 0.08, 0.10	0.04, 0.06, 0.08, 0.10	0.04, 0.06, 0.08, 0.10
Lemon Juice (g)	AAA_1 BBB_1 CCC_1 DDD_1	√ √ √ √	√ √ √ √
Tumeric powder (g)	AAA_2 BBB_2 CCC_2 DDD_2	√ √ √ √	√ √ √ √
Onion peel powder (g)	AAA_3 BBB_3 CCC_3 DDD_3	√ √ √ √	√ √ √ √
Ripe clove power (g)	AAA_4 BBB_4 CCC_4 DDD_4	√ √ √ √	√ √ √ √
Sodium Benzoate (as control preservative 0.03g/100g flour)	AAA √ √ √	AAA √ √ √	AAA √ √ √

Shelf – life Study on Preserved Bread/Cookies and Quality Evaluation

Experimental samples of organically preserved bread loaves and doughnut were each packaged in heat – sealed LDPE film and kept under room temperature (28 ±2°C) for daily routine inspection and analysis (sensory and microbiological properties) for 5 and 8 days respectively. While biscuit samples were similarly packaged, stored at room temperature 28±2°C) and subjected to weekly routine inspection and analysis (organoleptic and microbiological evaluation) for five weeks.

Sensory Evaluation: Organoleptic property, attributes of samples in storage (crust/crumb colour, taste, flavour, aroma, texture and mouthfeel as applicable to each product) were evaluated by fifteen (15) panelists, untrained but quite familiar with bread, doughnout and biscuit, based on 9 – point hedonic scales rating (Orishagbemi, *et al* 2019). Data were

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subjected to analysis of variance and separation of mean using standard technique (SPSS version 17).

Microbiological Analysis: Packaged samples of each product (bread, Doughnut, Biscuit) in storage at the ambient temperatures (28± 2°C) were subjected to determination to total plate count, mouth and coliform counts using standard microbiological techniques (Orishagbemi; *et al*, 2019).

RESULTS AND DISCUSSION

Sensory Properties of Organically Preserved Bread Loaves under Ambient Storage (5 days)

Table 1 shows the mean sensory attribute scores of bread samples with different preservatives, each applied at 4 concentration levels, kept under storage. Bread crust colour ratings ranged from 7.00 – 7.50 and 6.90 – 7.40 with the application fo lemon (AAA_1 – DDD_1 samples) and turmeric extract AAA_2 – DDD_2) respectively which varied slightly with increase in concentration (0.04 – 0.10g/100g of flour) found similar to the colour of control samples chemically preserved (0.03_g sodiumbenzoate/100g flour) and lower rating values of 5.30 – 6.60 for onion peel (AAA_3 – DDD_3) and clove (AAA_4 – DDD_4) organic extracts (0.04 – 0.1g/100g flour). There was no significant difference ($p \geq 0.05$) in colour among the preserved samples stored at the ambient for 5 days. The natural pigment of the individual extract powder affected bread crumb colour. The taste ratings ranged from 6.10 – 7.00 for samples AAA_1 – DDD_1 and AAA_2 – DDD_2, quite comparable with the control of rating 7.00 (sample AAA). All samples AAA_1 – DDD_1 and control retained initial taste up till 5 days in storage, while samples AAA_2 -DDD_2 (tumeric extract) could not retain taste beyond 3 days, and similar trend is observed in samples AAA_4- DDD_4 (clove extract). On the other hand, the taste of bread sample AAA_3 – DDD_3 (onion peel extract) were maintained up till 4 days. Decline in bread taste might be attributable to inability of preservative concentration at 0.10g/100g flour to prevent or inhibit staleness (loss of bifrigence) as result of very low content of active antioxidant in the preservative extract. The flavour and crumb texture of preserved bread loaves followed similar pattern as the taste, samples AAA_1 – DDD_1 (Lemon extract) retained flavour with ratings (6.40 – 6.80) and texture (5.6 – 7.0) for 5 days as the control (AAA, 0.03g SB/100g flour), while AAA_3 – DDD_3 (onion peel) and AAA_4 – DDD_4 (ripe clove) samples could retain bread flavour for only 3 days. Samples BBB_1 (0.06g lemon extract/100g flour) and AAA_2 (0.04g tumeric extract/100g flour) were most preserved for colour, flavour, taste and texture, and adjudged similar to the control, which kept for 5 days under ambient storage conditions without refrigeration. Reports have shown that pure ascorbic acid combined with sodium benzoate (chemical preservative) has retained bread quality (taste, flavour, crumb texture) for about 4 – 5 days for which only organic preservative extract has achieved in this work.

Sensory Properties of Organically Preserved Doughnut under Ambient Storage (8 days)

Table 2 shows the mean sensory attribute scores of doughnut samples with 4 different organic preservative extracts under ambient storage (28±2°C) for 8 days. Fresh Doughnut colour ratings ranged from 6.00-7.9, lowest for sample DDD_4 (0.1g clove extract and

highest being BBB_4 (0.06g clove extract) While samples DDD_1 (0.1g onion extract), CCC_2 (0.08g Tumeric), BBB_3 (0. 06g onion peel extract) and control AAA_1 (0.03g SB benzoate) have similar colour raings next to the highest. However, there was gradual decrease in the colour ratings as storage duration progressed uptill 8 days among all the samples, which was not significantly different ($P \geq 0.05$) among samples AAA_2 – DDD_2 for 3 days; control sample for 5 days, samples AAA_4 – DDD_4 for 6 days; samples AAA_1 – DDD_1 for 7 days and AAA_3 – DDD_3 for 8 days. Colour retention for longest duration 8 days AAA_3 – DDD_3 (Onion peel extract) and AAA_1 – DDD_1 lemon extract) is attributable to the attractive natural pigment of onion peel in doughnut which was probably resistant to depigmentation during storage and low pH of lemon extract also enhanced stable colour. The taste ratings ranged from 5.9 lowest (CCC_2 sample) to 7.9, highest (BBB_4 0.06g ripe clove) with variations among other samples, which were comparably better than the control, AAA (6.9 rating), especially samples DDD_1 0.1g lemon extract (7.3), CCC_3, 0.08g onion peel (7.6), and DDD_2, 0.1g tumeric extract (7.2) which retained initial taste for 5, 7, 8 and 4 days respectively prior to decline in taste during storage. The antioxidant in onion peel and tumeric extracts due to phenolic content is responsible for prevention of oxidative rancidity (frying oil) to retain taste of doughnut. Samples AAA (control), AAA_1, (0.04g) lemon extract), CCC_1 0.08g lemon, AAA_2 0.04 tumeric DDD_2, 0.1g tumeric and DDD_4 0.1g ripe clove have similar flavour rating (6.7-6.9), while BBB, 0.06g onion, DDD_4 0.1g lemon, AAA_3, 0.08g onion peel; CCC_3 0.08g onion peel, AAA_1, 0.04g clove and CCC_4, 0.1g clove also have similar rating (7.0 – 7.2), showing no significant difference ($p \geq 0.05$) among them. Duration of flavour retention followed the same trend as taste parameter, ranging from 5 days (control), 5days (AAA_4-CCC_4), 7 days (BBB_1 -DDD_1) to 8 days (AAA_3 and CCC_3). The natural flavour of individual extract slightly contributed to the doughnut flavour as has been reported by some researchers (Latif et al 2005). The texture ratings of doughnut samples ranged from 6.6 – 7.1 showing no significant difference ($p \geq 0.05$) among all of them regardless of the concentration level (0.04- 0.1g/100g) the type of organic preservative extract used and storage duration which was found to affect taste, colour and flavour.

Sensory Properties of Organically Preserved Biscuit under Ambient Storage (5 weeks)

The mean sensory attribute scores of experimental biscuit samples in storage are shown in table 3. Colour rating of biscuits from 6.7-8.1, 7.5 – 8.1, 6.6 – 7.7, 5.1 -6.1 and 8.30 with the incorporation of lemon extract (AAA_1 – DDD_1) tumeric extract (AAA_2- DDD_2) onion peel (AAA_3 – DDD_3) clove extract (AAA_4 – DDD_4) and sodium benzoate as control chemical preservative (AAA) respectively. There was no significant ($p \geq 0.05$) change in the attractive colour of samples preserved with lemon, Tumeric and onion peel extracts and control unlike clove extract within 5 weeks storage at the ambient temperature (28 ± 2°C). The natural pigment of extract in each case has contributed to the biscuit colour which was not degraded probably due to antioxidant phenolics available in the extract apart from ascorbic and which must have been affected by heat during biscuit baking.The range of taste attribute ratings included 6.6- 8.1 (lemon samples AAA_1-DDD_1) 6.4- 7.9 (tumeric samples AAA_2-DDD_2), 6.4- 7.3 (onion peel, AAA_3- DDD_3), 3.9- 6.1 (clove samples AAA_4- DDD_4) and 7.7 - 8.10 (control sample AAA with SB chemical

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ISSN: 2536-7331 (Print): 2536-734x (Online)
Volume 4, Number 4, December 2019
http://www.casirmediapublishing.com

preservative) within 5 weeks storage. It was found that biscuit samples AAA (control), AAA_1 (0.04 lemon extract /100g flour), CCC_1 (0.08g lemon extract /100g flour) retained taste throughout 5 weeks, while slight decrease observed in others without any significant difference ($p \geq 20.05$), but all samples with above extract (AAA_4 – DDD_4) had detenorated taste due to insufficient natural antioxidant to inhibit such. The flavour ratings followed the taste trend ranges including, 64- 8.1 (lemon extract metred samples, (AAA_2 – DDD_4), 606- 7.3 (turmeric extract AAA_2 – DDD_2), 6.6-7.2 (onion peel extract preserved samples AAA_3 – DDD_3), 4.3- 5.0 (clove preserved samples AAA_4-DDD_4) and 7.5- 7.8 (sodium benzoate preserved samples). Samples AAA_1- DDD_1 (lemon extract preserved samples 0.04- 0.1g concentration level) and AAA (0.03g SB chemical preservative) retained flavour of biscuit throughout 5 weeks under ambient storage. Similar to taste attribute. However, the flavour of clove extract preserved samples (AAA_4- DDD_4) was significantly different ($p \geq 0.05$) from others which was quite objectionable. The range of texture rating of biscuit samples included, 7.0 – 7.5 (tumeric extract, AAA_2- DDD_2), 6.1- 7.1 (onion peel extract, AAA3- DDD_3samples) and 4.5- 5.4 (control, SB chemical preservative. All the samples except onion peel and clove extract preserved retained texture regardless of the concentration throughout 5 weeks storage, they shil remained and crunchy and also the control (chemically preserved samples.)

Microbiological Contents of Preserved Bread (5 days), Doughnut (8 days) and Biscuit (5 weeks) Table 4 shows the microbiological content of organically preserved breads samples and control for 5 days at the ambient ($28 \pm 2^{\circ}C$). Total plate count cfu/g of fresh samples ranges included, 2.1 -3.1x 10^1(AAA_1- DDD_1) lemon extract), 1.5-2.2x10^1 (AAA_2-DDD_2, turmeric extract), 1.6-2.2x10^1 (AAA_3-DDD_3, onion peel extract), 1.8-3.1x10^1(AAA_3-DDD_3, onion peel extract), 1.8-3.1x10^1(AAA_4-DDD_4, clove extract) and 2.0x10^1 (AAA sodium benzoate as control). During storage, up to 5 days the TPC of samples AAA_1-DDD_1 and AAA ranged from 2.9 – 4.1x10^1. Showing slight increase over the initial TPC values which could be due to non-hermetic nature of packaged bread. These values are however low and found to be within acceptable and safe permissible/allowable limits for baked products such as bread. There were no detectable mould and coliform counts in these preserved samples. Sample preserved with turmeric extract (AAA_2-CC_2) showed traces of mould count (2x10^1MPN/g) in day 3, and all the samples discarded at the end of day 4. Similarly, onion peel extract preserved samples regardless of the concentration level, developed mould in day 4 (mould counts ranged from 1.5 – 6.5x10^1 MPN/g), so also with clove extract preserved bread, which developed moulds in day 3 and discarded at the end of day 4 in storage. Mould attack could be attributable to non-hermetic package that allowed air into the bread that carried mould spores and anti mould agent in organic preservative extract not sufficient to inhibit growth of such mould contaminant. Table 5 shows the microbiological content of organically preserved doughnut samples and the control in storage (8 days) at the ambient ($28 \pm 2^{\circ}C$). Total plate counts, TPC (cfu/g) of fresh doughnut samples had ranges of, 5.0-5.6x10^1 (AAA_1-DDD_1 lemon samples), 2.5-4.1x10^1(AAA_2-DDD_2, turmeric samples), 2.8-4.1x10^1 (AAA_3-DDD_3, onion peel extract), 2.6-4.0x10^1 (AAA_4-DDD_4, clove extract) and 5.2x10^1 (AAA- sodium Benzoate preservative as control and no mould and coliform detected. The TPC increased slightly

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as storage progressed up to 8 days, $5.3x10^{1}$-$5.2x10^{1}$ range for AAA_1-DDD_1 samples 3.1 -4.8 $x10^{1}$ for AAA_3-DDD_3 samples without mould and coliform counts. The TPC in the control increased to $5.3x10^{1}$ cfu/g in day 6 with detectable mould ($2.5x10^{1}$MPN/g) and discarded. TPC also increased in samples AAA_2-DDD_2 (tumeric extract preservative), with detectable moulds (2.1-$2.8x10^{1}$MPN/g) in day 4 and discarded, also there were increases in sample AAA_4 – DDD_4 (clove extract), with detectable moulds (1.9-3.6x101 MPN/g) in day 6 and discarded. This showed that mould growth was inhibited in samples preserved with lemon and onion peel extracts at the 4 concentration levels (0.04-0.1g/100 flour) due to anti mould agent present. On the other hands clove and turmeric could not inhibit mould. Mould growth in doughnut linger than 6 and 4 days respectively at the concentration levels used possibly due to low content or micro quantity of anti mould agent present. The microbiological contents of preserved biscuits samples and the control in storage (5weeks) at the ambient ($28\pm2^{o}C$) are shown in table 6. Total plate count, TPC (cfu/g) of fresh biscuits had ranges of 1.5-$2.2x10^{1}$(AAA_1-DDD_1 lemon samples), 1.8-$2.08x10^{1}$ (AAA_2 –DDD_2), turmeric samples), 2.1-$2.5x10^{1}$ (AAA_3-DDD_3, onion peel extract), 1.9-3./0x10^{1} (AAA_4-DDD_4) clove extract preservative) and $2.0x10^{1}$ (AAA, control, chemical preservative), while, moulds and coliform undetected. The TPC increased slightly in all the samples (1.9-$3.6x10^{1}$ cfu/g) but did not exceed allowable /permissible limit (10^{4}cfulg) for fried products to enhance safety (ICMSF, 2002). Apparently, neither moulds nor coliform were detected in fresh and preserved samples up to five (5) weeks under ambient temperature ($28\pm2^{o}C$) unlike bread and doughnut. This might be attributable to the air tightness of the biscuit package to disallow air/gas exchange, dryness, low moisture content and low water activity of the biscuit samples stored.

CONCLUSION

The use of organic /natural preservative extracts (lemon juice, turmeric, onion peel and cloves) at concentration levels of 0.04-0.10g/100g flour in bread, doughnut and biscuit cookies have been found to extend shelf life of these products stored under ambient temperature ($28\pm2^{o}C$) with retained sensory qualities, similar to using sodium benzoate as chemical/synthetic preservative. Bread loaf was preserved fresh for 5 days with lemon extract sample BBB_1 (0.06g/100g flour), doughnut for 8 days with onion peel extract, sample CCC_3 (0.08g/100flour) and biscuit for 5 weeks with lemon extract, sample CCC_1 (0.08g/100g flour), even longer extension than the control, sodium benzoate as synthetic preservative in each case. Total plate counts in preserved samples are quite low (2.0-3.3×10^{1}cfu/'g) and much more lower than allowable limits in baked/fried products (10^{4}cfu/g), while moulds not detected in outstanding samples under storage and coliform found completely absent in all the samples. Hence, both lemon and onion peel extracts are suitable alternatives to sodium benzoate as organic preservatives for bread and cookies.

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ISSN: 2536-7331 (Print): 2536-734x (Online)
Volume 4, Number 4, December 2019
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Table 1: Mean sensory attributes scores of bread samples preserved with different organic preservatives at various concentrations under ambient storage (28±2°C) for 5 days.

SAMPLE	SENSORY PARAMETER/STORAGE DURATION (DAYS)															
	Colour				Taste				Flavour				Crumb Texture			
	1	3	4	5	1	3	4	5	1	3	4	5	1	3	4	5
AAA	7.20±0.63^{a}	7.20±0.14^{a}	7.20±0.01	7.18±0.02	7.00±1.05	7.00±0.03	6.98±0.01	7.00±0.01	7.30±0.16	7.30±0.00	7.26±0.13	7.26±0.11	7.40±0.35	7.40±0.14	7.40±0.03	7.40±0.12
AAA_1	7.00±0.05^{a}	7.10±.0.12^{a}	7.00±1.10^{a}	7.00±0.01^{ab}	6.10±0.04^{b}	6.10±0.01^{b}	6.00±0.02^{b}	6.00±0.10^{bc}	6.30±0.05^{bc}	6.30±0.12^{c}	6.30±0.12^{c}	6.20±0.00^{c}	6.10±0.01^{c}	6.10±0.09^{c}	6.00±0.01^{c}	5.00±0.00^{d}
BBB_1	7.1±01.00^{a}	7.10±0.20^{a}	6.90±0.01^{ab}	6.90±0.03	6.60±0.01^{ab}	6.60±0.11^{ab}	6.50±0.00^{b}	6.50±0.11^{b}	6.80±0.03^{b}	6.80±0.03^{b}	6.70±0.07^{bc}	6.70±0.10^{bc}	7.00±0.01^{a}	7.00±0.02	6.90±0.00	6.80±0.04^{bc}
CCC_1	7.3±0.34^{a}	2.20±0.10^{a}	7.25±0.15^{a}	7.20±0.05	6.70±00.03^{ab}	6.65±0.01^{ab}	6.60±0.02^{b}	6.60±0.04^{b}	6.40±0.02^{b}	6.40±0.01^{bc}	6.35±0.03^{c}	6.30±0.00^{bc}	5.50±0.00^{c}	5.80±0.12	5.75±0.00	5.70±0.03^{d}
DDD_1	7.20±0.29^{a}	7.00±0.30^{a}	7.10±0.01^{a}	7.10±0.00	6.50±0.11^{ab}	6.60±0.02^{ab}	6.50±0.001^{b}	6.50±0.12^{b}	5.80±0.08^{c}	5.80±0.03^{c}	5.80±0.00^{d}	5.70±0.01^{a}	5.60±0.03^{d}	5.70±0.11	5.70±0.09	5.60±0.02^{d}
AAA_2	7.40±0.15^{a}	7.400.05a	-	-	6.70±0.07^{ab}	6.50±1.0^{ab}	-	-	6.20±0.09^{c}	5.85±0.11^{c}	-	-	7.00±0.14	6.90±0.20^{b}	-	-
BBB_2	6.90±0.57^{a}	6.900.57a	-	-	5.90±0.12^{bc}	5.80±0.9^{c}	-	-	6.30±0.11^{c}	6.20±0.02^{bc}	-	-	6.60±0.11	6.50±0.15^{b}	-	-
CCC_2	7.60±0.60^{ab}	7.600.06ab	-	-	5.80±0.03^{c}	5.80±0.06^{c}	-	-	6.00±0.10^{c}	6.00±0.10^{bc}	-	-	6.10±0.07	6.00±0.09^{bc}	-	-
DDD_2	7.200.30^{a}	7.200.30a	-	-	7.00±0.07^{a}	6.80±0.14^{ab}	-	-	6.60±0.08^{ab}	6.40±0.05^{b}	-	-	6.80±0.15	6.80±0.14^{b}	-	-
AAA_3	6.20±0.10^{b}	6.19±0.03^{b}	6.18±0.11$_{b}$	-	5.90±0.13^{c}	5.80±0.18^{c}	5.75±0.11^{bc}	-	5.20±0.07^{c}	5.20±0.10	5.10±0.01	-	5.40±0.10	5.40±0.00	5.40±0.01^{d}	-
BBB_3	6.59±0.35^{b}	6.59±0.13^{b}	6.58±0.20$_{b}$	-	6.60±0.11^{b}	6.40±0.09^{b}	6.30±0.11^{b}	-	6.20±0.12^{bc}	6.10±0.06	6.00±0.21	-	5.60±0.11	5.50±0.00	5.40±0.11^{d}	-
CCC_3	6.20±0.75^{b}	6.21±0.50^{b}	6.20±0.14^{b}	-	6.00±0.21^{b}	5.90±0.12^{b}	5.80±0.13^{c}	-	5.80±0.06^{c}	5.80±0.11	5.60±0.09	-	5.10±0.14	5.00±0.00	4.90±0.07^{e}	-

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DDD$_3$	6.60±0.38^{b}	6.65±0.28^{b}	6.60±0.06^{b}	-	5.90±0.04^{c}	5.85±0.05^{c}	5.70±0.01^{c}	-	5.90±0.11^{c}	5.70±0.10	5.60±0.11	-	5.40±0.08	5.35±0.00^{d}	5.30±0.11^{d}	-
SAMPLE	SENSORY PARAMETER/STORAGE DURATION (DAYS)															
AAA$_4$	5.30±0.50^{c}	5.30±0.19^{bc}	-	-	5.90±0.11^{c}	5.80±0.07^{c}	-	-	5.50±0.10^{c}	5.30±0.07^{d}	-	-	4.80±0.03^{e}	4.80±0.00^{e}	-	-
BBB$_4$	6.20±1.0^{b}	6.21±1.01^{ab}	-	-	6.10±0.02^{b}	6.00±0.14^{b}	-	-	6.10±0.21^{b}	5.90±0.02^{c}	-	-	5.50±0.01^{d}	5.40±0.10^{d}	-	-
CCC$_4$	5.30±0.70^{c}	5.29±0.29^{bc}	-	-	5.50±0.02^{bc}	5.50±0.05^{bc}	-	-	5.20±0.08^{bc}	5.00±0.06^{d}	-	-	5.10±0.00^{d}	5.10±0.06^{d}	-	-
DDD$_4$	5.80±0.40^{c}	5.85±0.32^{bc}	-	-	5.90±0.11^{c}	5.85±0.08^{c}	-	-	5.20±0.05	5.10±0.11^{d}	-	-	4.90±0.00`	4.80±0.02^{e}	-	-

Values represent means of 15 panelists ± SD (Standard Deviation).
Means in a column with the same superscript are not significantly different ($p \geq 0.05$). Samples codes
Sample Codes
AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),
CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),
CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,
CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),
CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

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	Colour					Taste					Flavour					Texture				
	1	2	4	6	8	1	2	4	6	8	1	2	4	6	8	1	2	4	6	8
AAAA	7.60±0.13^{a}	7.60±0.09^{a}	7.5±0.01^{a}	7.5±0.12^{a}	-	6.90±0.11^{b}	6.90±0.01^{b}	6.70±0.00^{b}	5.90±0.23b^{c}	-	6.70±0.14^{b}	6.70±0.11^{b}	6.00±0.10^{c}	5.22±0.12^{bc}	-	6.60±0.11^{b}	6.60±0.11^{b}	6.60±0.11^{b}	6.60±0.11^{b}	6.60±0.11^{b}
AAA_1	6.60±0.03^{b}	6.60±0.00^{b}	6.5±0.11^{b}	6.4±0.02^{b}	6.00±0.11^{c}	7.10±0.03^{a}	7.00±0.10^{a}	6.9±0.12^{a}	6.7±0.11^{b}	5.8±0.02^{c}	6.8±0.11^{b}	6.8±0.14^{b}	6.5±0.00	6.5±0.00	5.2±0.12	5.7±0.00	5.7±0.03	5.6±0.00	5.6±0.11	5.6±0.20
BBB_1	7.50±0.10^{a}	7.5±0.3^{a}	7.3±0.01^{a}	7.3±0.09^{a}	6.8±0.13^{b}	7.0±0.10^{b}	7.1±0.05^{b}	7.0±0.11^{b}	6.8±0.20^{c}	5.5±0.10^{d}	7.10±0.03	7.1±0.07	6.8±0.10^{b}	6.6±0.11^{b}	6.4±0.10^{b}	6.7±0.06^{b}	6.7±0.01^{b}	6.7±0.11	6.6±0.11	6.6±0.11
CCC_1	6.70±0.01^{b}	6.7±0.04^{b}	6.5±0.02^{b}	6.4±0.01^{b}	6.0±0.00^{c}	6.3±0.08^{c}	6.3±0.21^{c}	6.0±0.12^{c}	5.8±0.06^{d}	5.4±0.05^{d}	6.9±0.00^{c}	6.9±0.03^{c}	6.7±0.21^{c}	6.6±0.10^{c}	6.2±0.01	6.5±0.01	6.5±0.00	6.5±0.10	6.4±0.10	6.4±0.03
DDD_1	7.60±0.13^{a}	7.6±0.00	7.6±0.10	7.6±0.20	7.40±0.01	7.3±0.01	7.3±0.11	7.0±0.01	6.8±0.14	5.9±0.02	7.1±0.12	7.1±0.12	7.1±0.08	7.0±0.18	6.5±0.03	7.0±0.02	7.0±0.04	6.9±0.02	7.0±0.00	7.0±0.00
AAA_2	7.40±0.21^{a}	7.3±0.19^{a}	7.3±0.14^{a}	-	-	7.0±0.11^{a}	6.5±0.12^{b}	5.4±0.11^{d}	-	-	6.9±0.14^{c}	6.8±0.12^{c}	5.7±0.00^{e}	-	-	7.8±0.12^{a}	7.6±0.03^{a}	6.5±0.11^{c}	-	-
BBB_2	7.00±0.01^{ab}	7.0±0.11^{ab}	6.5±0.11^{c}	-	-	6.4±0.15^{c}	6.4±0.00^{c}	5.2±0.00^{d}	-	-	6.10±0.01^{c}	6.0±0.01^{c}	5.5±0.11^{d}	-	-	6.5±0.10^{c}	6.4±0.11^{c}	6.2±0.00	-	-
CCC_2	7.60±0.39^{a}	7.5±0.06^{a}	7.3±0.00^{a}	-	-	5.9±0.04^{c}	5.8±0.01^{c}	5.0±0.06^{d}	-	-	5.5±0.06	5.4±0.07	5.7±0.21	-	-	6.8±0.10	6.7±0.00	6.6±0.10	-	-
DDD_2	6.7±0.11^{ab}	6.7±0.01^{ab}	6.8±0.11^{ab}	-	-	7.2±0.10^{a}	7.0±0.11^{b}	6.8±0.02^{c}	-	-	6.9±0.00	6.7±0.10	5.9±0.31	-	-	6.6±0.13	6.4±0.02	6.2±0.11	-	-
AAA_3	7.7±0.22^{a}	7.7±0.17^{a}	7.7±0.02^{a}	7.6±0.12^{a}	7.5±0.00^{a}	6.8±0.13^{c}	6.9±0.13^{c}	6.7±0.11	6.7±0.11	6.6±0.00	7.0±0.00	7.0±0.11	7.1±0.21	7.0±0.11	6.8±0.11	7.1±0.12	7.2±0.01	7.0±0.00	7.1±0.11	7.1±0.04
BBB_3	7.6±0.	7.6±0.07	7.4±0.1	7.5±0.0	7.2±	7.0±	7.1±	7.0	7.0±0.0	6.9±	6.6±0.1	6.7±0.	6.6±0.1	6.7±0.2	6.8±0.	7.2±0.0	7.2±0.0	7.0±0.1	7.0±0.01	7.0±0.

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	12[a]	[a]	1[a]	0[a]	0.12[a]	0.10[b]	0.25[b]	±0.12	0	0.00	1	00	3		03	1	6	1		01
CCC_3	6.5±0.00[b]	6.5±0.11[c]	6.5±0.06[c]	6.4±0.02	6.4±0.03[c]	7.6±0.08[a]	7.6±0.16[a]	7.6±0.10	7.5±0.13	7.4±0.00	7.2±0.15	7.2±0.21	7.0±0.10	7.1±0.01	7.1±0.11	6.5±0.10	6.6±0.11	6.6±0.13	6.6±0.01	6.6±0.01
DDD_3	7.0±0.01[ab]	7.0±0.13[b]	7.0±0.0[b]	7.0±0.11	7.0±0.20[b]	5.5±0.06[a]	5.6±0.11[d]	5.4±0.11	5.4±0.11	5.4±0.00	6.1±0.02	6.1±0.12	6.1±0.11	6.0±00.00	6.±0.001	6.6±0.11	6.7±0.01	6.6±0.10	6.6±0.01	6.5±0.10
AAA_4	7.3±0.10[ab]	7.3±0.059	7.1±0.12	6.7±0.02	-	6.7±0.11[c]	6.4±0.20[c]	6.2±0.00	6.0±0.20[c]	-	7.1±0.20[b]	6.8±0.16[c]	6.6±0.01[c]	6.0±0.14[d]	-	6.8±0.00[c]	6.8±0.11[c]	6.8±0.11[c]	6.6±0.12	6.4±0.11
BBB_4	7.9±0.02[a]	7.6±0.019	7.4±0.04	7.1±0.0[b]	-	7.9±0.21[a]	7.6±0.07[a]	7.4±0.13	6.8±0.12	-	7.6±0.15[a]	7.1±0.01[b]	6.9±0.05[c]	6.5±0.06[d]	-	7.1±0.02[b]	7.0±0.00[b]	7.0±0.00[b]	6.7±0.20	6.3±0.20
CCC_4	6.3±0.00[c]	6.1±0.00[c]	6.1±0.31[c]	5.9±0.20[c]	-	6.7±0.22[c]	6.6±0.03	6.4±0.21	6.2±0.11	-	7.0±0.11[b]	6.8±0.10[b]	6.6±0.10[d]	6.4±0.019	-	6.7±0.05[c]	6.5±0.00[c]	6.5±0.00[c]	6.2±0.17	6.0±0.13
DDD_4	6.0±0.01[c]	6.1±0.11[c]	5.8±0.03[d]	5.6±0.01[d]	-	7.0±0.03	6.9±0.014	6.7±0.09[c]	6.4±0.00[c]	-	6.9±0.10[c]	6.8±0.09[c]	6.5±0.17[d]	6.6±0.09[d]	-	6.9±0.11[c]	6.8±0.13[c]	6.8±0.13[c]	6.5±0.11	6.4±0.12

Table 2: Mean sensory attribute scores of Doughnut samples preserved with different organic preservative extracts under ambient storage (28±2°C) for 8 days.
Values represent means of 15 panelists ± SD (Standard Deviation).
Means in a column with the same superscript are not significantly different ($p \geq 0.05$). Samples codes
AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),
CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),
CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

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AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,
CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),
CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

Table 3: Mean sensory attributes scores of Biscuit samples preserved with different organic preservatives extracts under ambient storage (28±2°C) for 5 weeks.

SAMPLE	SENSORY PARAMETER/ STORAGE DURATION (WEEKS)											
	Colour			Taste			Flavour			Texture		
	1wk	3wks	5wks	1wk	3wks	5wks	1wk	3wks	5wks	1wk	3wks	5wks
AAA	8.30±0.02^{a}	7.8±0.10^{a}	7.9±0.20^{a}	8.10±0.11^{a}	7.9±0.03^{a}	7.7±0.05^{b}	7.80±0.00^{ab}	7.8±0.10^{ab}	7.5±0.02^{ab}	7.50±0.11^{ab}	7.4±0.02^{ab}	7.40±0.01^{a}
AAA_1	8.1±0.15^{a}	7.9±0.07^{a}	7.7±0.12^{ab}	8.1±0.03^{a}	8.0±0.01^{a}	7.9±0.11^{ab}	7.1±0.11^{a}	7.9±0.00^{ab}	7.8±0.02^{ab}	7.5±0.01^{b}	7.3±0.01^{b}	7.3±0.00^{b}
BBB_1	6.7±0.04^{c}	6.5±0.12^{d}	6.6±0.04^{c}	6.8±0.11^{c}	6.6±0.00^{d}	6.2±0.03^{c}	7.1±0.01^{bc}	7.0±0.12^{b}	6.7±0.11^{c}	7.0±0.03^{b}	7.0±0.20^{b}	7.1±0.025
CCC_1	7.6±0.11	7.4±0.12^{b}	7.1±0.01^{b}	8.0±0.20^{a}	7.9±0.01^{b}	7.8±0.01^{ab}	7.6±0.13^{ab}	7.2±0.10^{b}	7.0±0.01^{b}	7.6±0.05^{ab}	7.3±0.22^{ab}	7.3±0.12^{b}
DDD_1	7.4±0.05^{ab}	7.4±0.00^{ab}	7.2±0.10^{b}	7.2±0.06^{b}	7.1±0.00^{bc}	6.9±0.10	6.9±0.02^{c}	6.7±0.01^{c}	6.4±0.00^{d}	6.9±0.11^{c}	-	-
AAA_2	8.0±0.62^{a}	7.8±0.13^{ab}	7.6±0.11^{b}	7.7±0.06^{b}	7.4±0.10^{bc}	7.1±0.11^{b}	7.2±0.01^{ab}	7.0±0.03^{b}	6.9±0.04^{c}	7.5±0.14^{b}	7.3±0.10^{ab}	7.3±0.12^{b}

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BBB_2	7.6±0.00^{ab}	7.5±0.07^{ab}	7.4±0.16^{b}	7.6±0.02^{b}	7.3±0.04^{bc}	7.0±0.00^{b}	7.2±0.11^{ab}	6.9±0.11^{c}	6.6±0.11^{c}	7.1±0.06	7.0±0.11^{b}	7.0±0.11^{b}
CCC_2	7.5±0.13^{ab}	7.3±0.03^{ab}	7.3±0.15^{b}	6.9±0.11^{c}	6.6±0.12	6.4±0.06	7.2±0.10^{ab}	7.0±0.20^{ab}	6.7±0.06^{c}	7.5±0.00^{b}	7.2±0.21^{b}	7.0±0.10
DDD_2	8.1±0.04^{a}	8.0±0.01^{a}	7.0±0.16^{ab}	7.9±0.20^{b}	7.8±0.20^{ab}	7.6±0.13^{ab}	7.3±0.14^{ab}	7.2±0.17^{ab}	7.0±0.0.13^{ab}	7.3±0.18^{bc}	7.3±0.11^{ab}	7.2±0.00^{b}
AAA_3	6.7±0.11^{ab}	6.4±0.01^{cd}	6.2±0.01^{cd}	6.7±0.01^{c}	6.5±0.00^{d}	6.2±0.11^{d}	6.7±0.10^{d}	6.8±0.00^{c}	6.6±0.11^{c}	6.1±0.0.11^{d}	6.2±0.10^{d}	6.1±0.01^{d}
BBB_3	6.6±0.08^{ab}	6.5±0.12^{cd}	6.4±0.10^{c}	6.9±0.11^{c}	6.6±0.11^{d}	6.4±0.12^{d}	7.1±0.03	6.9±0.12^{c}	6.7±0.16^{c}	6.4±0.01^{cd}	6.2±0.17^{d}	6.1±0.11^{d}
CCC_3	7.7±0.01^{a}	7.5±0.00^{b}	7.2±0.12^{b}	7.3±0.20^{ab}	7.0±0.08^{ab}	6.8±0.06^{cd}	7.2±0.12^{b}	7.0±0.07^{ab}	6.7±0.14^{c}	7.0±0.00^{b}	6.9±0.20^{cd}	6.9±0.00^{c}
DDD_3	7.2±0.04+	7.0±0.14^{b}	6.9±0.14^{c}	7.3±0.11^{ab}	7.1±0.01^{ab}	7.0±0.10^{ab}	7.1±0.00^{b}	7.0±0.04^{ab}	6.8±0.01^{c}	7.6±0.00^{ab}	7.7±0.13^{b}	7.1±0.05^{b}
AAA_4	5.3±0.00^{d}	5.0±0.11^{e}	4.8±0.16^{e}	5.6±0.12^{d}	5.2±0.22^{e}	5.1±0.12^{e}	5.2±0.00^{e}	5.0±0.11^{e}	4.8±0.10^{f}	5.4±0.11^{f}	5.1±0.02^{e}	5.0±0.11^{e}
BBB_4	5.5±0.12^{d}	3.±0.03^{e}	5.0±0.20^{de}	5.3±0.02^{d}	5.2±50.08^{e}	4.9±0.00^{f}	5.0±0.11^{e}	4.8±0.05^{f}	4.3±0.02^{f}	4.9±0.00^{f}	4.8±0.11^{f}	4.6±0.10^{f}
CCC_4	5.1±0.03^{bd}	4.9±0.00^{ef}	4.6±0.21^{de}	4.3±0.11^{e}	4.0±0.12^{f}	3.9±0.11^{ef}	4.9±0.04^{f}	4.7±0.02^{f}	4.5±0.11^{f}	4.6±0.01^{f}	4.5±0.03^{f}	4.3±0.12^{f}
DDD_4	6.1±0.01^{e}	6.4±0.12^{cd}	6.1±0.02^{cd}	5.0±0.03^{de}	4.8±0.06^{ef}	4.7±0.02^{ef}	4.8±0.01^{f}	4.6±0.13^{f}	4.5±0.11^{f}	4.6±0.11^{f}	4.6±0.05^{f}	4.4±0.20^{f}

Values represent means of 15 panelists ± SD (Standard Deviation).
Means in a column with the same superscript are not significantly different ($p \geq 0.05$). Samples codes

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AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),
CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),
CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,
CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),
CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

Table 4: Microbiology contents of organically preserved Bread samples stored for 5 days at the ambient conditions (28±2°c)
Storage Duration (days)/ microbiological Parameters
Samples: Day 1

SAMPLE	Day 1			Day 4			Day 6			Day 8		
	TPC	MC	CF	TPC	MC	CF	TPC	MC	CF	TPC	MC	CF
AAA	2.0X101	-	-	2.0X101	-	-	2.1X101	-	-	2.9X101	-	-
AAA_1	2.1X101	-	-	2.1X101	-	-	2.6X101	-	-	3.0X101	-	-
BBB_1	2.0X101	-	-	2.2X101	-	-	2.5X101	-	-	3.1X101	-	-
CCC_1	3.X101	-	-	3.0X101	-	-	3.2X101	-	-	3.6X101	-	-
DDD_1	3.1X101	-	-	3.2X101	-	-	3.5X101	-	-	4.1X101	-	-

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AAA_2	2.2x101	-	-	2.4x101	2x101	-	Discarded	-	-	-	-	-
BBB_2	1.5x101	-	-	1.8x101	-	-	-	-	-	-	-	-
CCC_2	2.0x101	-	-	2.1x101	-	-	-	-	-	-	-	-
DDD_2	2.0x101	-	-	2.1x101	-	-	-	-	-	-	-	-
AAA_3	2.2x101	-	-	2.2x101	3x101	-	-	2.2x101	6x101	Discarded	Discarded	-
BBB_3	2.0x101	-	-	2.0x101	-	-	-	2.3x101	6.5x101	-	-	-
CCC_3	1.6x101	-	-	1.6x101	-	-	-	1.9x101	1.5x101	-	-	-
DDD_3	2.0x101	-	-	2.1x101	-	-	-	2.1x101	3x101	-	-	-
												-
AAA_4	3.1x101	-	-	3.1x101	-	-	-	Discarded	-	-	-	-
BBB_4	2.1x101	-	-	2.4x101	3x101	-	-	-	-	-	-	-
CCC_4	2.0x101	-	-	2.0x101	4x101		-	-	-	-	-	-
DDD_4	1.8x101	-	-	1.8x101	.5x101	-	-	-	-	-	-	-

Values represent means, n=2

Sample codes

TPC = Total plate count (cfu/g), M.C. = Mould count (MPN/g), CF = Coliform (MPN/g).

AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),

CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),

CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,

CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),

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CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

Table 5: Microbiology contents of Doughnut samples stored for 8 days at the ambient conditions (28±2°c)
Storage Duration (days)/ microbiological Parameters
Samples: Day 1

SAMPLE	Day 1			Day 4			Day 6			Day 8		
	TPC	MC	CF	TPC	MC	CF	TPC	MC	CF	TPC	MC	CF
AAA	5.2x101	-	-	5.2x101	-	-	5.3X101	-	-	Discarded	-	-
AAA_1	5.6x101	-	-	5.7x101	-	-	5.7X101	-	-	5.7x101	-	-
BBB_1	5.0x101	-	-	5.0x101	-	-	5.1X101	-	-	5.7x101	-	-
CCC_1	5.2x101	-	-	5.2x101	-	-	5.2X101	-	-	5.2x101	-	-
DDD_1	5.2x101	-	-	5.0x101	-	-	5.1X101	-	-	5.3x101	-	-
AAA_2	4.1x101	-	-	4.4x101	2.8X101	-	Discarded	-	-	-	-	-
BBB_2	4.0x101	-	-	4.1x101	2.7X101	-	3.0x101	-	-	-	-	-
CCC_2	2.5x101	-	-	2.7x101	2.1X101	-	3.1x101	-	-	-	-	-
DDD_2	3.6x101	-	-	3.8x101	1.8X101	-	4.5x101	-	-	3.0x101	-	-
AAA_3	2.8x101	-	-	2.8x101	-	-	4.2x101	-	-	3.4x101	-	-
BBB_3	3.0x101	-	-	3.0x101	-	-	3.8x1	-	-	4.8x101	-	-
CCC_3	4.1x101	-	-	4.2x101	-	-	4.3x101	-	-	4.4x101	-	-
DDD_3	4.0x101	-	-	4.0x101	-	-	3.2x101	2.1x101	-	Discarded	-	-
AAA_4	3.3x101	-	-	3.3x101	-	-	3.2x101	1.9x101	-	-	-	-
BBB_4	3.9x101	-	-	4.1x101	-	-	-	3.6x101	-	-	-	-

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CCC_4	2.6x101	-	-	2.8x101	1.2X10	-	-	2.8x101	-	-	-	-
DDD_4	4.0x101	-	-	4.2x101	1.0X101	-	4.4x101	-	-	-	-	-

Values represent means, n=2
Sample codes
TPC = Total plate count (cfu/g), M.C. = Mould count (MPN/g), CF = Coliform (MPN/g).

AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),
CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),
CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,
CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),
CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

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Table 6: Microbiology contents of organically preserved biscuit samples stored for 5 weeks at the ambient conditions (28±2°c)
Storage Duration (weeks)/ microbiological Parameters
Samples: week 1

SAMPLE	WEEK 1			WEEK 3			WEEK 5		
	TPC	MC	CF	TPC	MC	CF	TPC	MC	CF
AAA	2.0×101	-	-	2.0x 101	-	-	2.5x101	-	-
AAA_1	2.0×101	-	-	2.1x101	-	-	2.6x101	-	-
BBB_1	2.1×101	-	-	2.1x 101	-	-	2.1x101	-	-
CCC_1	2.2x 101	-	-	2.7x 101	-	-	2.6x 101	-	-
DDD_1	1.5x101	-	-	1.6x101	-	-	2.2x101	-	-
AAA_2	1. 9x 101	-	-	1.8x101	-	-	2.1x101	-	-
BBB_2	2.0x 101	-	-	2.2x101	-	-	2.5x101	-	-
CCC_2	1.8 x 101	-	-	1.9x101	-	-	1.9x101	-	-
DDD_2	1.9 x 101	-	-	1.9x101	-	-	2.3x101	-	-
AAA_3	2.1 x101	-	-	2.3x101	-	-	2.7x101	-	-
BBB_3	2.0 x 101	-	-	2.1x101	-	-	2.2x101	-	-
CCC_3	2.5 x 101	-	-	2.5x101	-	-	2.5x101	-	-
DDD_3	2.1 x101	-	-	2.1x101	-	-	2.5x101	-	-
AAA_4	2.8 x101	-	-	2.8x101	-	-	3.0x101	-	-
BBB_4	3.0 x 101	-	-	3.2x101	-	-	3.6x 101	-	-
CCC_4	2.2 x 101	-	-	2.2x101	-	-	2.4x101	-	-
DDD_4	1. 9 x101	-	-	1.9x 101	-	-	2.2x101	-	-

Values represent means, n=2

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Sample codes
TPC = Total plate count (cfu/g), M.C. = Mould count (MPN/g), CF = Coliform (MPN/g).

AAA - Sodium Benzoate, 0.03g/100g Flavour

AAA_1 – Lemon Juice extract (0.04/100g flour) , BBB_1 – Lemon Juice extract (0.06g/100g flour),
CCC_1 – Lemon Juice extract (0.08g/100g flour), DDD_1 – Lemon Juice extract (0.10g/100g flour),

AAA_2 – Tumeric extract (0.04/100g flour), BBB_2 – Tumeric extract (0.06g/100g flour),
CCC_2 – Tumeric extract (0.08g/100g flour), DDD_2 – Tumeric extract (0.10g/100g flour)

AAA_3 – Onion peel extract (0.04/100g flour), BBB_3 – Onion peel extract (0.06g/100g flour) ,
CCC_3 – Onion peel extract (0.08g/100g flour), DDD_3 – Onion peel extract (0.10g/100g flour)

AAA_4 – Clove extract (0.04/100g flour), BBB_4 – Clove extract (0.06g/100g flour),
CCC_4 – Clove extract (0.08g/100g flour), DDD_4 – Clove extract (0.10g/100g flour)

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http://www.casirmediapublishing.com

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