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# PRODUCTION OF WHITE SOFT CHEESE FORTIFIED WITH NATURAL ANTIOXIDANTS AS A FUNCTIONAL DAIRY FOOD

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**ABSTRACT:** This study was carried out to estimate the antioxidant activity and phenolic compounds of peanut skin, potato peels and rice bran extracts and to study the effect of addition of these natural extracts on soft cheese quality, each extract was added to cheese milk during manufacture at a rate of 0.5 to 1%. Cheese chemical composition, oxidative stability, microbiological examination and organoleptic properties of cheese, when fresh and after 30, 60 and 90 days storage at room temperature were done. Results showed that these extracts have a high content of phenolic compounds, and gave high antioxidtion activity. The addition of these extracts to cheese milk did not significantly affect on the chemical composition but affected the oxidative stability, bacteriological and organoleptic properties of cheese samples. A clear reduction was observed in peroxide value (PV), acid value (AV) and Thiobarbituric acids (TBA) content of cheese samples containing natural extracts during storage period than control cheese samples without antioxidant (control A) and those containing 0.02% Butylated hydroxyanisole (BHA) (as positive control B). Total bacterial, coliform and yeast and mould counts of cheese samples containing natural extracts did not detected during storage compared with control (A) cheese samples and those containing BHA as control (B). Also, results showed that organoleptic properties of all cheese treatments improved by progressed of storage period until the end of storage. Cheese containing potato peels and rice bran extracts at ratio of 1% showed better appearance, flavour intensity and body characteristics than other cheeses. From the previous results, some natural extracts could be used in white soft cheese manufacture such as potato peels, rice bran and peanut skin extracts at a rate of 1%, where it improved the sensory and bacteriological characteristics of cheese samples and increased stability against oxidation.

**Key words:** Potato peel, rice bran, peanut skin, phenolic compounds, white soft cheese.

## INTRODUCTION

Many studies reported that one of the principal causes of food quality deterioration is lipid peroxidation. These results of lipid peroxidation is the formation of reactive oxygen species and free radicals, which arepurportedly associated with carcinogenesis, mutagenesis, inflammation, DNA changes, aging and cardiovascular diseases (**Siddhuraju and Becker, 2003; Shahid *et al.,* 2008**). The antioxidant is one of the most significant active components that play an important role in reducing oxidation process. The antioxidants are considered the most important food additives. As well as, they play many roles during food processing as preservatives, prevent formation of harmful and unwanted compounds in food and preserve the colour of a food item (**Rubalya and Neelamegam, 2012**).

Antioxidants are an inhibitor of oxidation, even at relatively small concentration and thus have diverse physiological role in the body. Antioxidant constituents of the plant material act as radical scavengers, and help in converting the radicals to less reactive species. A variety of free radical scavenging antioxidants is found in dietary sources like fruits, vegetables and tea (**Jang *et al.,* 2012**).

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A number of natural antioxidants have been added during food processing and have elongated the self-life and oxidative stability of stored products. In addition, researches has indicated that natural phenolic compounds can be extracted from raw materials or waste products of food industry (**Peschel *et al.*, 2006; Xiaowei *et al.*, 2011**) Synthetic antioxidants *e.g.* ( Tetra-butyl hydroquinone (TBHQ), BHA and Butylated hydroxytoluene (BHT) are widely used as food additives, but their application has been reassessed because of possible toxic or carcinogenic components formed during their degradation **Pitchaon *et al.* (2007)**. In recent years, the study of by-products as natural source of antioxidant and antimicrobial has become a subject of worldwide interest. It is well known that antioxidants such as natural and synthetic play an important role in retarding lipid oxidation reactions in food products. It was reported that the natural antioxidants occur in all higher plants and all parts of the plant (wood, bark, steams, pods, leaves, fruits, root, flowers and seeds).

Amount of plant biomass wastes are produced yearly as by- product from agro-food industries.

During rice milling, rice bran is produced as by- product which is to be an excellent source of mineral and vitamins (**Zullaikah *et al.*, 2005**). On the other hand, rice bran has a high nutritive value and beneficial health such as blood cholesterol lowering and laxative effect (**Qureshi *et al.*, 2001**).

Peanut (*Arachis hypogaea* L. Fabaceae), the fourth oleaginous plant in the world, is known to be one of the most important economical crops owing to its wide distribution, nutritional characteristics, and its great application in the food industry for centuries. Studies were conducted to study antioxidants properties of peanut, peanut kernels, peanut hulls and peanut-based products. Peanut skins were demonstrated to be rich in phenolics and other health promoting compounds (**Yu *et al.*, 2005,2010; Wang *et al.*, 2007; Monagas *et al.*, 2009**).

Sweet potato is increasingly recognized as a health food, due to several of its nutraceutical components, which include dietary fiber, vitamin C, polyphenols, and carotenoids. The roots are considered as a highly functional, low calorie food, with anti-diabetic effects. Reports indicate that these phytochemicals, especially polyphenols, have high free-radical scavenging activity, which help to reduce the risk of chronic diseases, such as cardiovascular disease, cancer and age-related degenerative diseases (**Padmaja, 2009**). Although potato peels are being used for feeding livestock, by-products from potato processing industry still outpace such limited utilization. Another aspect was its utilization as a source for natural antimicrobial compounds (**Balasundran *et al.*, 2006; Prasad and Pushpa, 2007; Akyol *et al.*, 2016**).

Rice consumed by over half of the world's population. It is primarily cultivated in Asian countries, including China, Thailand, Japan, and Korea (**Dutta *et al.*, 2012**). Rice bran (the outer layer) is removed during the milling process to obtain white rice. However, rice bran contains most of the biological components that include phenolic compounds, anthocyanins, phytic acid, γ-oryzanols, tocotrienols and tocopherols, which were previously reported as antioxidants (**Moongngarm and Saetung, 2010; Ghasemzadeh *et al.*, 2015**).

Rice grain contains with gallic, caffeic, ferulic, vanillic, syninginc, cinnamic and protocatechuic acids which reported as common phenolic acids (**Sosulski *et al.*, 1982**).

Generally, addition of antioxidants in Food containing lipids is one method to minimize rancidity, retard the formation of toxic oxidation products. Maintain nutritional quality and increase the shelf life. Therefore, much attention has been focused on natural antioxidants from plant wastes. In addition, peanut skins, rice bran and potato peels are consider wastes or by-products. These wastes are good sources of natural antioxidants. Many studies reported that antioxidants such as (flavonoids, tannis, coumarins, curcumanids, xanthose, phenolics, lignans and terpenoids) are found in various plant parts *e.g.* (fruits, leaves, seeds and oils), (**Sotillo *et al.*, 1994a,b; Al-Shikan, 1995; Pin-Der and Gow-Chin, 1997; Jeong *et al.*, 2004; Mohdaly *et al.*, 2009**). For these reason is growing interest in separating these plant antioxidants from the it's wastes and using them as natural antioxidants in fat food products are arising.

In this context, the potato peel (*Solanum tuberosum*), may be considered as a new source of natural antioxidants, similar in effectiveness to synthetic antioxidants, considering that it is rich in phenolic compounds, some in free form and some bounded, directly related to the antioxidant activity of its extracts, and that actuate over the minimization of non-desired effects from the products of the food lipid oxidation (**Rehman *et al*., 2004; Mansouri *et al.*, 2005**).

Previous reports have been shown that potato peels (as a wastes or by-product of potato processing) have antioxidant activity in several *in vitro* assay system **Singh and Rajini (2008)**. Aqueous extract of potato peels is rich in virous phenolic acids including hydroxyl cinnamic acids and flavonoids, which have strong antioxidant capapality (**Albishi *et al.,* 2013)** and offer therapeutic effect including production of erythrocytes without having mutagenic (**Sotillo *et al.,* 1998**). On the other hand, the possess antimicrobial activity was occurred by adding most phenolic extracts (**Jin *et al.,* 2009)**. The new aspects concerning use of these wastes as by- product for further exploitation in the production of food additives or supplements with higher nutritional value have gained increasing interest due to their high value products and their recovery may be economically attractive (**Vasso and Constantina, 2007**).

The present study was planned to measure the antioxidant activity and total phenolic compounds of potato peels, rice bran and peanut skins extracts and effect of adding these extracts to cheese milk on it's oxidative stability, microbiological and organoleptic properties during storage at room temperature for 90 days.

# MATERIALS AND METHODS

## Materials

Potato peels (PP) (*Solanum tuberosum*), peanut skins (PS) (*Arachis hypogaea* L.) and rice bran (RB) were obtained from locally market, then washed with distilled water. The starting materials were dried in air drying oven (40°C) until the moisture content became 12% or less. By-products were ground and sieved through 60-mesh sieve and finally kept at 4°C until extractions. Butylated hydroxy anisole (BHA), 1, 1-diphenyl-2-picrylhydrazyl (DPPH), gallic acid and quercin were purchased from Sigma (St. Louis, MO, USA). All other chemicals and reagents were of the highest purity.

## Methods

### Preparation of extracts

Dried materials were extracted with ethanol with 80%, at a ratio of 10:1 (*V/W*, 10 ml solvent: 1 g raw material) in closed vessels by stirring at room temperature (25°C) for 4 hr., followed by filtration through Whatmann NO.1 filter paper. The residues were reextracted again under the same conditions. All vessels were wrapped with aluminum foil to prevent light degradation during extraction (**Yu *et al*., 2005**). The solvents were evaporated in a rotary evaporator (Buchi-water bath-B-480, Switzerland) at 40°C, and the residues were freeze-dried (Thermo Electron Corporation- Heto Power Dry LL 300 Freeze Dryer, Czechoslovak). The dried extracts after evaporation were weighed to determine the yield and stored at -20°C until used.

### Determination of total phenolic compounds (TPC)

The concentration of TPC in different extracts was measured using UV spectrophotometer (Jenway-UV–VIS Spectrophotometer), based on a colorimetric oxidation/reduction reaction, as described by **Skerget *et al.* (2005)** using Folin-Ciocalteu reagent. Brifly, 0.5 ml of diluted extract (10 mg in 10 ml solvent) was mixed with 2.5 ml of Folin–Ciocalteu reagent (diluted 10 times with distilled water) and 2 ml of $Na_2CO_3$ (75 g/1 L). The sample was incubated for 5 min at 50°C then cooled. For the control sample, 0.5 ml of distilled water was used. The absorbance was measured at 760 nm. Total phenolic content expressed as gallic acid equivalent (GAE) was calculated, and the results were expressed as an mg GAE/g extract.

### Identification of phenolic acids using HPLC

Phenolic acids of the dried extracts were identified according to the method described by **Mattila *et al.* (2000)**. HPLC (Hewllet Packard series 1050, USA) equipped with autosampling injector, solvent degasser, UV detector set at 330 nm and quarter HP pump (series 1050) was

used. Column (C18 hypersil BDS) with particle size 5 µl was used. The separation was carried out with methanol and acetonitrile as a mobile phase at flow rate of 1 ml/min. The column temperature was performed at room temperature (25°C) throughout the experiment. Identification and quantification were carried out based on calibrations of the standards prepared from phenolic acids dissolved in a mobile phase. Retention time and peak area were used for calculation of phenolic acid compounds by the data analysis of Hewllet Packared Software.

**Radical scavenging activity (RSA) of extracts**

The electron donation ability of the obtained extracts was measured by bleaching of the purple coloured solution of 1,1-diphenyl-2-picrylhydrazyl (DPPH), according to **Hanato *et al.* (1988)**. One hundred µl of each extract (10 mg extract/10 ml solvent) was added to 3 ml of 0.1 mM DPPH dissolved in ethyl acetate, ethanol and hexane according to the solvent used for extraction. After incubation period for 60 min at room temperature, the absorbance was determined against a control at 517 nm (**Gulcin *et al.*, 2004**). Percentage of antioxidant activity of DPPH was calculated as follows:

DPPH scavenging activity (%) = [(A0- A1)/ A0]×100 where, A0 is the absorbance of the control reaction and A1 is the absorbance of the extract. Samples were analyzed in triplicate

**Manufacture of soft cheese fortified with natural antioxidants**

Fresh bulk buffalo's milk, containing 6% fat, were pasteurized at 63°C for 30 min. Calcium chloride and sodium chloride were added at the ratios of 0.02% and 6% (*W/V*) respectively. The treated milk was divided into 8 portions. The first portion was left without any additives served as a control (A). The BHA as synthetic antioxidant was added to the second portion at ratio of 200ppm (0.02%) as a positive control (B). Ethanolic potato peel extract (PPE) was added to the 3$^{rd}$ and 4$^{th}$ portions at rate of 0.5, and 1% respectively. Also, ethanolic extract of rice bran (RBE) was added to the 5$^{th}$ and 6$^{th}$ portions at rate of 0.5, and 1%. While peanut skin extract (PSE) was added to the 7$^{th}$ and 8$^{th}$ portions at the rate of 0.5 and 1%, respectively. White soft cheese were made by the method of (**Fahmi and Sharara, 1950**).

Cheese treatments were put in plastic containers with formerly boiled saline (10% salt) and stored at room temperature (25±1°C) for 90 days, cheese samples were analyzed chemically, microbiologically and orgnaoleptically when fresh and then after 30, 60 and 90 days of storage.

## Chemical Analyses

White soft cheese was chemically analyzed for total solids, fat and titratable acidity as described by **AOAC (2007)**. pH value was measured in cheese samples using a digital pH meter. Total and soluble nitrogen percentages were determined by semi-micro Kjeldhal method as described in the **AOAC (2007)**. Total volatile fatty acids (TVFA) of soft cheese were estimated according to **Kosikowski (1982)**.

**Oxidative stability tests**

Cheese fat was extracted from the samples according to **Abd El-Fattah (2006)**. Cheese samples were dried at 40°C for 12 hr., in drying oven, ground and mixed with n-hexane as a solvent for extraction of fat. The solvent was evaporated at 40°C. Peroxide and acid values of white soft cheese fat were determined according to **AOAC (2007)**.Thiobarbituric acid contents (TBA) of white soft cheese fat was determined according to **Keeny (1971)**.

## Microbiological Examination

One gram of each cheese sample treatments was taken at the age of 0, 30, 60 and 90 days and carefully weighted under aseptic condition into sterile watch glass and then transferred to a sterile mortar which was previously sterilized by flaming.

One ml of 20% sterilized sodium citrate solution was placed in the mortar and the sample was thoroughly ground into homogenous suspension, by means of a sterile pastille. Finally, 8 ml of a sterile saline solution, previously warmed to 37°C, were added and mixed well given the 1: 10 dilution, which was used for preparing the other dilutions, (**APHA, 1992**).

The total bacterial count of white soft cheese was determined according to **Difico Manual**

**(1984)** using Tryptone Glucose Extract Agar (TGEA) medium; plates were incubated at 37°C for 2 to 3 days. Total coliform count was estimated by plating suitable dilutions on MacConkey agar medium as described by (**APHA, 1992**). The plates were incubated for 24 hr., at 35±1°C, and the small non-mucoid red colonies were counted. The total yeasts and moulds count of white soft cheese was determined according to (**APHA, 1992**), by plating suitable dilutions in duplicates on Sabouraud Dextrose Agar medium (**Oxoid Mannual, 1965**). Plates were incubated at 28°C for 3 days then the yeasts were counted at 28°C for 5 days to counting the yeast and moulds

**Sensory properties of cheese**

The sensory properties of cheese samples were assessed by 10 panel members of the Food Sci., Dept., Fac. Agric., Zagazig, Univ. for flavour (50) body and texture (40) and appearance (10) according to **Scott (1981)**.

## Statistical Analysis

Statistical analysis for the obtained data was carried out using SPSS version 20 computer program (**Dominick and Derrick, 2001**). All data were expressed by means and standard deviations of three replicates were compared using one-way ANOVA and least significant difference (LSD) values with different letters within the same column differ significantly at ($P \geq 0.01 – 0.05$).

# RESULTS AND DISCUSSION

## Yield of Extracts

The yield of potato peels, rice bran and peanut skin extracts varied from 9.86-8.24 g/ 100g (Table 1). Ethanolic PSE had higher yield (9.86 g/100g) followed by ethanolic PPE (9.32g/ 100g) and finally RBE (8.24 g/100g). The variation in the extraction yield may be attributed to its content of total phenol compounds and the polarity of compounds in plants. Such differences had been reported by **Prakasha *et al.* (2001)**.

## Total Phenolic Compounds

PSE, PPE and RBE were analyzed for total phenols (Table 1). The results showed that PSE had the highest percentage of total phenols (312.48 mg/100 g), followed by PPE (294.82 mg/g) and finally RBE (286.32 mg/g).These results agree with those reported by **Monagas *et al.* (2009), Ghasemzadeh *et al.* (2015)** and **Akyol *et al.* (2016)**.

Therefore, PPE, RBE and PSE could be a good source of bioactive compounds, which have high antioxidative properties.

## Identification of Phenolic Compounds by HPLC

It is obvious that TPC measured by the Folin-Ciocalteu procedure does not give a full picture of the quality or quantity of the phenolic constituents in the extracts as reported in literature (**Katsube *el al.,* 2004**). HPLC is the preferred technique for both separation and quantification of phenolic compounds) (**Naczk and Shahidi, 2004**). The HPLC analysis of the phenolic and flavonoid compounds in PSE, PPE and RBE were employed using the previous condition and were compiled in Table 2. Several phenolic compounds, which are representative of the diverse structural types, were identified.

Results in Table 2 show that PSE contained the highest total phenolic and flavonoid compounds content, followed by PPE, while RBE contained the lowest total phenolic compounds.

The major compound in PSE is Gallic, chlorogenic, catachin, quercetin, protocatechuic and vanillic acid. The major compound in PPE are gallic, chlorogenic, caffien, coumaric acid and vanillic acid while the major compound in RBE are catechin, chlorogenic, quercetin and vanillic acid, phenolic compounds identified in PSE ranged from 7.48 to 106.47 mg/g.. Phenolic compounds identified in PPE ranged from 3.20 to 112.24 mg/g. While phenolic compounds identified in RBE ranged from 2.08 to 12.62 mg/g these results are in agreement with those reported by **Monagas *et al.* (2009), Ghasemzadeh *et al.* (2015)** and **Akyol *et al.* (2016)**.

Gallic acid is phytochemicals that are considered a potential source of functional food ingredients for their high antioxidant capacity (**Sethiya *et al.,* 2014**).

Quercetin is an another phytochemical flavonoid that has attracted great interest

**Table 1. Yield and total phenolic compounds of potato peels, rice bran and peanut skin extracts**

| Extract | Yield (g/100g) | Total phenolic compounds (mg/g) |
|---|---|---|
| **Potato peels (PPE)** | 9.32 | 294.82 |
| **Rice bran (RBE)** | 8.24 | 286.32 |
| **Peanut skin (PSE)** | 9.86 | 312.48 |

**Table 2. Identification of phenolic compounds in ethanol extracts of various materials as determined by HPLC**

| Compound | Potato peels extract PPE (mg/g) | Rice bran extract RBE (mg/g) | Peanut skins extract PSE (mg/g) |
|---|---|---|---|
| **Gallic** | 22.40 | 12.14 | 7.48 |
| **Syringicacid** | ND | 11.22 | ND |
| **Protocatechuic** | 7.82 | 7.28 | 50.77 |
| **Chlorogenic** | 32.68 | 11.46 | 25.83 |
| **Caffien** | 14.80 | 10.92 | 5.47 |
| **Catechin** | 8.42 | 5.14 | 106.47 |
| **Ferulic** | 3.20 | 12.62 | ND |
| **Cinnamic** | ND- | 9.04 | ND |
| **Quercetin** | 8.12 | 2.08 | 8.33 |
| **Apigenin** | 6.40 | 3.18 | 2.17 |
| **Coumaric acid** | 18.36 | ND | ND |
| **Vanillic acid** | 112.24 | ND | 19.8 |
| **Cryptochlorogenic acid** | 46.28 | ND | ND |

ND = Not Detected

because it is a potent antioxidant with proven anticancer effects; its structure contains a double bond in the C ring and a 4- oxo group, which enhance its antioxidant activity (**Moskaug *et al.*, 2004**).

The differences in composition presented between the extracts may be due variety, degree of ripeness of the plant used and the method of extraction. An important factor is the solvent used for the extraction of phenolic compounds, because solvents with different polarity extracted different compounds in varying quantities (**Mohdaly *et al.*, 2010**).

## Radical Scavenging Activity (RSA) of Plant Ethanolic Extracts

The tests expressing antioxidant potency can be categorized into two groups: assays for radical scavenging ability and assays that test the ability to inhibit lipid oxidation under accelerated conditions. However, the model of scavenging stable free radicals is widely used to evaluate the antioxidant properties in a relatively short time, as compared to other methods (**Schwarz *et al.*, 2000**). The results of ethanolic extract radical scavenging activity (RSA) assays

with DPPH as a control are shown in Table 3. The radical scavenging activity of the three studied materials showed high values. It was (90.46%) for PSE and (88.65%) for PPE. While RBE was (86.22%).

The DPPH test provides information on the activity of the tested compounds with a stable free radical. DPPH gives a strong absorption band at 515 nm in visible region. When the add electron becomes paired off in the presence of a free radical scavenger, the absorption reduced and the DPPH solution is assayed as the colour changes from deep violet to high yellow. The degree of redaction in absorbance measurement is indicative of the radical scavenging (antioxidant) power of the extract. The obtained results are similar to that reported by **Ramadan *et al.* (2003)**.

## Gross Chemical Composition of White Soft Cheese

Results presented in Table 4 show the effect of natural antioxidant ethanolic extracts (NAEE) from different sources (peanut skins, potato peals and rice bran) on chemical composition of cheese samples (moisture, titratable acidity, F/DM and salt/moisture (%) and total volatile fatty acid (TVFA) content) of white cheese samples during ripening. It could be observed that moisture content of cheese from all treatments gradually decreased throughout the repining period especially after 30 days of storage. Also, these results show that all cheese containing natural antioxidant ethanolic extracts (NAEE) (0.5 or 1%) had significantly ($P \geq 0.05$) increased in moisture content compared with control. This may be due to the antimicrobial effect of NAEE on acid development in cheese, which is in relationship with whey expulsion during storage (**Monagas *et al.*, 2009; Moongngarm and Saetung, 2010; Andreia *et al.*, 2015**). On the other hand, moisture content of all treatments significantly ($P \geq 0.05$) decreased up to 90 days .These results are in agreement with those found by **Salem *et al.* (2010)** and **Abdel-Aziz *et al.* (2012)**. Concerning fat content as affected by NAEE (Table 4). It could be observed those fat /DM content of experimental cheese samples increased significantly ($P \geq 0.05$) up to the end of storage period depending on the loss of moisture. These results are in agreement with those reported by **Abdel-Aziz *et al.* (2012)**, who manufactured soft cheese using ginger extract as natural antioxidant. The results showed that the salt/ moisture content of all cheese treatments increased with the progress of storage period (Table 4). This could be due to the loss in water because of water exudation during pickling which in turn lead to more salt concentration. Similar results were obtained by **Salem *et al.* (2010)**. These results showed that there was not different significance ($P \geq 0.05$) in salt /DM of all treatments during ripening. Also the same Table shows that titratable acidity increased gradually until the end of storage period ($P \geq 0.05$). The control cheese samples (Table 4) without antioxidant (A) had a higher titratable acidity than all other cheese treatments after 30 days of storage. An important observation that control cheese (A) and BHA fortified cheese (B) had higher acidity than other treatments during ripening up to 90 days. However, cheese containing natural antioxidants showed lower titratable acidity. This may be due to higher antimicrobial activity of these extracts (**Prasad and Pushpa, 2007; Monagas *et al.*, 2009; Moongngarm and Saetung, 2010; El-Sohaimy, 2014**). Similar results were obtained by **Abdel-Aziz *et al.* (2012)** and **Ruben *et al.* (2013)**. Also, results showed that TN (%) of cheese samples increased gradually up to 90 days, and there were no significant differences in TN (%) along with the storage period.

Table 5 shows solable nitrogen/total nitrogen (SN/TN) and non protein nitrogen/ total nitrogen (NPN/TN) (%) and TVFA contents of cheese containing different percentages of natural extracts. It is noticed that both SN/TN and NPN/TN contents of all cheese treatments slow gradually increased during storage period. This increase may be due to the break down occurred by the growth and activities of microflora and/or proteolysis with proteolytic enzymes. These results indicated that addition of different antioxidant extracts did not show remarkable proteolysis during ripening. These results are in agreement with those reported by **Salem *et al.* (2010)** and **Abdel-Aziz *et al.* (2012)**.

Table 5 shows the average TVFA content of cheese made from all treatments. Results indicated that there were significant differences ($P \geq 0.05$) in TVFA content of cheese samples as compared with control (A and B) when fresh and during the storage period. Control cheese (A) had higher TVFA content than control (B) and other cheese samples treated with NAEE up to 90 days. Similar results were obtained by **Abdel-Aziz *et al.* (2012)**.

**Table 3. Radical scavenging effect of ethanolic potato peel, rice bran and peanut skin extracts on DPPH radical scavenging as measured by changes at 515 nm.**

| Radical scavenging activity (RSA) (%) | Material | | |
|---|---|---|---|
| | Potato peel extract (%) | Rice bran extract (%) | Peanut skin extract (%) |
| | 88.65 % | 86.22 % | 90.46 % |

**Table 4. Chemical composition of white soft cheese as affected by adding different natural antioxidants during storage at room temperature**

| Property | Storage period (day) | Soft cheese made with natural antioxidant ethanolic extract (NAEE) | | | | | | | | LSD | Significant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Control | | Rice bran | | Potato peel | | Peanut skin | | | |
| | | Without antioxidant | With BHA (0.02 %) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% | | |
| Moisture (%) | 0 | $61.13^{b}$ | $64.15^{a}$ | $64.12^{a}$ | $64.20^{a}$ | $63.95^{a}$ | $63.78^{a}$ | $64.10^{a}$ | $63.90^{a}$ | 0.440 | *** |
| | 30 | $59.10^{d}$ | $61.16^{ab}$ | $61.50^{a}$ | $61.11^{ab}$ | $61.10^{ab}$ | $60.95^{a}$ | $60.19^{c}$ | $60.19^{c}$ | 0.358 | *** |
| | 60 | $57.12^{d}$ | $60.10^{a}$ | $59.10^{b}$ | $59.90^{a}$ | $60.11^{a}$ | $58.12^{c}$ | $59.10^{b}$ | $59.7^{a}$ | 0.481 | *** |
| | 90 | $55.96^{d}$ | $59.74^{a}$ | $58.19^{b}$ | $58.08^{b}$ | $59.13^{a}$ | $57.09^{c}$ | $58.09^{b}$ | $59.16^{a}$ | 0.703 | *** |
| Fat/DM (%) | 0 | $44.80^{bc}$ | $44.90^{bc}$ | $45.43^{abc}$ | $45.60^{ab}$ | $45.25^{bc}$ | $45.69^{ab}$ | $44.40^{c}$ | $46.40^{a}$ | 0.737 | ** |
| | 30 | $45.96^{ab}$ | $45.06^{bc}$ | $46.50^{a}$ | $46.02^{ab}$ | $46.14^{a}$ | $45.65^{abc}$ | $44.71^{c}$ | $44.71^{c}$ | 0.724 | *** |
| | 60 | $46.88^{c}$ | $45.93^{d}$ | $46.21^{cd}$ | $47.74^{b}$ | $50.38^{a}$ | $48.47^{b}$ | $50.00^{a}$ | $50.37^{a}$ | 0.749 | *** |
| | 90 | $50.39^{bc}$ | $50.06^{bc}$ | $49.50^{cd}$ | $49.52^{cd}$ | $50.89^{b}$ | $48.85^{d}$ | $49.88^{bc}$ | $52.85^{a}$ | 0.643 | *** |
| Salt/Moisture (%) | 0 | $9.65^{a}$ | $9.25^{a}$ | $9.23^{a}$ | $9.25^{a}$ | $9.32^{a}$ | $9.25^{a}$ | $9.23^{a}$ | $9.30^{a}$ | 1.051 | NS |
| | 30 | $10.08^{a}$ | $9.81^{a}$ | $9.72^{a}$ | $9.79^{a}$ | $9.82^{a}$ | $9.79^{a}$ | $9.68^{a}$ | $9.99^{a}$ | 0.617 | NS |
| | 60 | $10.71^{a}$ | $10.32^{a}$ | $10.45^{a}$ | $10.35^{a}$ | $10.35^{a}$ | $10.63^{a}$ | $10.49^{a}$ | $10.42^{a}$ | 0.728 | NS |
| | 90 | $11.15^{ab}$ | $10.58^{b}$ | $11.62^{a}$ | $10.95^{ab}$ | $10.76^{ab}$ | $11.00^{ab}$ | $10.88^{ab}$ | $10.75^{ab}$ | 0.569 | NS |
| Tetratable acidity (%) (as lactic acid) | 0 | $0.23^{a}$ | $0.27^{a}$ | $0.24^{a}$ | $0.28^{a}$ | $0.25^{a}$ | $0.27^{a}$ | $0.25^{a}$ | $0.26^{a}$ | 0.057 | NS |
| | 30 | $0.88^{a}$ | $0.89^{a}$ | $0.87^{a}$ | $0.90^{a}$ | $0.86^{a}$ | $0.90^{a}$ | $0.87^{a}$ | $0.88^{a}$ | 0.069 | NS |
| | 60 | $1.38^{b}$ | $1.55^{a}$ | $1.38^{b}$ | $1.42^{b}$ | $1.36^{b}$ | $1.40^{b}$ | $1.46^{b}$ | $1.40^{b}$ | 0.071 | *** |
| | 90 | $1.88^{a}$ | $1.80^{b}$ | $1.77^{b}$ | $1.72^{b}$ | $1.75^{b}$ | $1.71^{b}$ | $1.75^{b}$ | $1.70^{b}$ | 0.072 | *** |
| Total protein (%) | 0 | $15.05^{a}$ | $15.18^{a}$ | $14.93^{a}$ | $15.12^{a}$ | $14.80^{a}$ | $14.67^{a}$ | $14.93^{a}$ | $14.67^{a}$ | 0.845 | NS |
| | 30 | $16.58^{a}$ | $16.08^{ab}$ | $15.50^{b}$ | $15.63^{b}$ | $15.67^{b}$ | $15.63^{b}$ | $15.39^{b}$ | $15.31^{b}$ | 0.548 | ** |
| | 60 | $17.55^{a}$ | $16.72^{a}$ | $16.72^{a}$ | $16.84^{a}$ | $16.78^{a}$ | $16.78^{a}$ | $16.78^{a}$ | $16.80^{a}$ | 0.842 | NS |
| | 90 | $17.86^{a}$ | $17.67^{a}$ | $17.36^{a}$ | $17.61^{a}$ | $17.61^{a}$ | $17.99^{a}$ | $17.86^{a}$ | $18.11^{a}$ | 0.783 | NS |

Means with the same letter are not significantly different NS : Not significant ** :high significant
***: very high significant LSD: Least significant difference at ($P \geq 0.05$)

**Table 5. Proteolysis and lipolysis of white soft cheese as affected by adding different natural antioxidants during storage at room temperature**

| Property | Storage period (day) | Soft cheese made with natural antioxidant ethanolic extract (NAEE) | | | | | | | | LSD | Significant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Control | | Rice bran | | Potato peel | | Peanut skin | | | |
| | | Without antioxidant | With BHA (0.02 %) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% | | |
| SN/TN (%) | 0 | 5.90$^{a}$ | 5.16$^{a}$ | 5.48$^{a}$ | 5.46$^{a}$ | 5.30$^{a}$ | 5.72$^{a}$ | 5.80$^{a}$ | 5.76$^{a}$ | 0.880 | NS |
| | 30 | 10.95$^{d}$ | 9.11$^{e}$ | 10.90$^{d}$ | 11.70$^{cd}$ | 12.15$^{c}$ | 13.10$^{ab}$ | 13.80$^{a}$ | 12.90$^{b}$ | 0.712 | *** |
| | 60 | 18.90$^{a}$ | 18.50$^{a}$ | 17.25$^{b}$ | 18.60$^{a}$ | 18.50$^{a}$ | 17.10$^{b}$ | 17.90$^{ab}$ | 17.20$^{b}$ | 0.837 | *** |
| | 90 | 24.60$^{a}$ | 23.50$^{b}$ | 22.90$^{b}$ | 23.70$^{b}$ | 23.10$^{b}$ | 22.86$^{b}$ | 23.10$^{b}$ | 22.95$^{b}$ | 0.741 | ** |
| NPN/TN (%) | 0 | 3.93$^{ab}$ | 3.19$^{b}$ | 3.13$^{b}$ | 4.60$^{a}$ | 4.17$^{ab}$ | 4.08$^{ab}$ | 3.06$^{b}$ | 4.80$^{a}$ | 0.874 | ** |
| | 30 | 7.62$^{a}$ | 6.67$^{a}$ | 6.58$^{a}$ | 7.35$^{a}$ | 6.50$^{a}$ | 7.35$^{a}$ | 6.25$^{a}$ | 6.25$^{a}$ | 0.887 | * |
| | 60 | 11.36$^{a}$ | 9.92$^{b}$ | 9.90$^{b}$ | 9.85$^{b}$ | 9.12$^{b}$ | 9.13$^{b}$ | 9.92$^{b}$ | 9.61$^{b}$ | 0.804 | *** |
| | 90 | 11.78$^{a}$ | 11.67$^{a}$ | 11.76$^{a}$ | 10.79$^{a}$ | 11.23$^{a}$ | 11.70$^{a}$ | 10.71$^{a}$ | 10.92$^{a}$ | 0.829 | * |
| TVFA (ml NaOH 0.1 N/1 00 g cheese) | 0 | 10.14$^{b}$ | 11.40$^{a}$ | 11.36$^{a}$ | 11.30$^{a}$ | 10.30$^{b}$ | 10.70$^{ab}$ | 10.70$^{ab}$ | 9.92$^{b}$ | 0.618 | *** |
| | 30 | 20.30$^{a}$ | 19.90$^{ab}$ | 19.23$^{abc}$ | 18.60$^{bc}$ | 19.17$^{abc}$ | 19.20$^{abc}$ | 18.87$^{bc}$ | 18.22$^{c}$ | 0.863 | ** |
| | 60 | 26.30$^{a}$ | 22.44$^{c}$ | 22.10$^{c}$ | 21.18$^{d}$ | 23.76$^{b}$ | 23.15$^{b}$ | 21.56$^{cd}$ | 22.14$^{c}$ | 0.662 | *** |
| | 90 | 30.12$^{a}$ | 27.88$^{b}$ | 27.10$^{c}$ | 26.16$^{c}$ | 26.80$^{c}$ | 26.12$^{c}$ | 26.70$^{c}$ | 25.10$^{d}$ | 0.738 | *** |

Means with the same letter are not significantly different NS :Non significant
** :high significant ***: very high significant LSD : Least significant difference at (P≤0.05)

## Oxidative Stability

### Peroxide values (PV)

It is well known that the initial and primary products of lipid oxidation are hydroperoxides, which hydrolyze and broken to ketones and aldehydes as incubation advanced (**Krishnamurthy, 1982**). These components may be broken to nonvolatile and secondary products, which decrease the quality of the initial stage of oxidative changes (**Erwin *et al.*, 2004**). In the present study, oxidation degree was determined by measuring peroxide values (PV) during storage period up to 90 days of white soft cheese containing NAEE and control cheese without antioxidant (A) and cheese contained BHA (B) as positive control. Results presented in Table 6 show the development of peroxide values (PV), thiobarbituric acid (TBA) and acid value (AV) of all cheese samples during storage period up to 90 days. The results showed that a continuous increase in PV with the increase of storage period for all cheese samples. It is clear from these results that PV of the control cheese without antioxidant (A) was significantly ($P \geq 0.05$) higher than control cheese with BHT (B) and all cheese treated with natural antioxidant during ripening up to 90 days.

Also, the results showed that there were significant differences in PV between all treatments, all cheeses contained on NAEE decreased peroxide value ($P \geq 0.05$) compared with control cheese without antioxidant (A) cheese contained BHA (B).

On the other hand, peanut skin extracts showed a higher significant decrease ($P \geq 0.05$) of PV than both PPE and RBE extracts. Moreover, the natural antioxidant extracts activity of peanut skin, potato peels and rice bran increased with increasing extracts concentration. These results are in accordance with those of **Sabeena *et al.* (2012)** and **Silva-Bbeltr *et al.* (2016)**.

Also, results agree with **Andreia *et al.* (2015)**, who reported that proto cheese containing mate tea leaves extracts at 0.1 or 0.2% decreased pH values and retarded fat oxidation during repining. These results are in accordance with those reported by **Tian *et al.* (2004 and 2005)** who decided that rice bran is a good source of many bioactive compounds and phytochemicals known as natural antioxidants including phenolic compounds.

Also, the results indicated that the peroxide values decreased with increasing concentration of ethanolic extracts of natural antioxidant used.

**Table 6. Oxidative stability of white soft cheese as affected by adding different natural antioxidants during storage at room temperature**

| Property | Storage period (day) | Soft cheese made with natural antioxidant ethanolic extract (NAEE) | | | | | | | | LSD | Significant |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Control | | Rice bran | | Potato peel | | Peanut skin | | | |
| | | Without antioxidant | With BHA (0.02 %) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% | | |
| Peroxide value (meq / kg) | 0 | 4.80$^{a}$ | 4.38$^{b}$ | 4.20$^{c}$ | 3.92$^{d}$ | 4.17$^{c}$ | 3.85$^{d}$ | 4.13$^{c}$ | 3.75$^{e}$ | 0.073 | ** |
| | 30 | 9.28$^{a}$ | 8.40$^{b}$ | 8.10$^{c}$ | 7.55$^{e}$ | 8.05$^{c}$ | 7.42$^{e}$ | 7.96$^{d}$ | 7.20$^{g}$ | 0.070 | *** |
| | 60 | 13.60$^{a}$ | 12.00$^{b}$ | 11.57$^{c}$ | 10.74$^{f}$ | 11.42$^{d}$ | 10.50$^{g}$ | 11.25$^{e}$ | 10.33$^{h}$ | 0.068 | *** |
| | 90 | 19.20$^{a}$ | 14.50$^{b}$ | 12.05$^{c}$ | 11.10$^{f}$ | 11.94$^{d}$ | 11.00$^{g}$ | 11.75$^{e}$ | 10.82$^{h}$ | 0.068 | *** |
| | Means | 11.72 | 9.82 | 8.98 | 8.33 | 8.90 | 8.19 | 8.77 | 8.03 | | |
| Thiobarbituric acid (TBA) at 512 nm. | 0 | 0.165$^{a}$ | 0.151$^{b}$ | 0.146$^{c}$ | 0.135$^{d}$ | 0.144$^{c}$ | 0.131$^{de}$ | 0.141$^{c}$ | 0.180$^{e}$ | 0.005 | *** |
| | 30 | 0.172$^{a}$ | 0.157$^{b}$ | 0.150$^{c}$ | 0.140$^{de}$ | 0.149$^{c}$ | 0.136$^{ef}$ | 0.145$^{cd}$ | 0.130$^{f}$ | 0.006 | *** |
| | 60 | 0.130$^{a}$ | 0.208$^{b}$ | 0.196$^{c}$ | 0.182$^{d}$ | 0.194$^{c}$ | 0.180$^{d}$ | 0.190$^{c}$ | 0.173$^{f}$ | 0.006 | *** |
| | 90 | 0.350$^{a}$ | 0.270$^{b}$ | 0.226$^{c}$ | 0.203$^{e}$ | 0.219$^{d}$ | 0.199$^{ef}$ | 0.215$^{d}$ | 0.195$^{f}$ | 0.005 | *** |
| | Means | 0.204 | 0.197 | 0.180 | 0.165 | 0.177 | 0.162 | 0.173 | 0.170 | | |
| Acid value (mg KOH/g fat) | 0 | 0.80$^{a}$ | 0.75$^{b}$ | 0.73$^{bc}$ | 0.68$^{d}$ | 0.71$^{cd}$ | 0.65$^{e}$ | 0.70$^{cd}$ | 0.63$^{e}$ | 0.030 | *** |
| | 30 | 1.09$^{a}$ | 0.98$^{b}$ | 0.96$^{bc}$ | 0.89$^{d}$ | 0.95$^{c}$ | 0.87$^{de}$ | 0.94$^{c}$ | 0.85$^{e}$ | 0.025 | *** |
| | 60 | 1.30$^{a}$ | 1.19$^{b}$ | 1.14$^{bc}$ | 1.05$^{def}$ | 1.12$^{bcd}$ | 1.03$^{ef}$ | 1.10$^{cde}$ | 1.00$^{f}$ | 0.064 | *** |
| | 90 | 1.56$^{a}$ | 1.25$^{b}$ | 1.23$^{bc}$ | 1.16$^{cd}$ | 1.21$^{bcd}$ | 1.14$^{d}$ | 1.20$^{bcd}$ | 1.13$^{d}$ | 0.062 | *** |
| | Means | 1.188 | 1.043 | 1.015 | 0.945 | 0.998 | 0.923 | 0.985 | 0.903 | | |

Means with the same letter are not significantly different NS :Non significant ** :high significant
***: very high significant LSD : Least significant difference at (P≤)

**Han *et al.* (2011 a and b)** reported that a functional cheese products containing polyphenolic compound was developed, and the polyphenolic retention efficiency and antioxidant property of product evaluated.

These results also are in accordance with that reported by **Bandyopadhyay *et al.* (2007)** who found that ginger rhizome extract exhibited the highest antioxidant activity and had an activity comparable to commercial antioxidants such as (TBHQ, BHA and BHT). Also, these results reflected the important role of natural antioxidant for inhibition of fat oxidation in the resultant cheese during storage up to 90 days.

Cheese samples contained peanut skin extracts had significantly ($P \geq 0.05$) the lowest peroxide values followed by potato peels and then rice bran extracts, when compared with control cheese (A and B). This could be attributed to that peanut skin extracts had high content of phenolic acid compounds, which play an important role in retarding fat rancidity during storage. The results obtained are in agreement with **Yen *et al.* (1993)** who reported that peanut hull exhibited marked antioxidant activity as a results of their containing a considerable amount of phenolic compound which retard fat rancidity and help to improve the stability of lipid peroxidation. O n the other hand, our results are in agreement with those obtained by **Puravankara *et al.* (2000)** and **Pankaj *et al.* (2013)** who found that obtained of ethanolic extract of *T. arjuna* bark at 7% by weight was highly effective in retarding the auto oxidation in both cow and buffalo ghee during storage. **Bandyopadhyay *et al.* (2007)** found that the

addition of solvent extract of mint, beet and ginger showed the higher antioxidant activity compared with any other from.

Also, these results are in agreement with those reported by **Rashidinejad *et al.* (2015)** who studied the effect of (+) Catechin on the composition and phenolic content of hard full-fat cheese during ripening and measured the recovery (by HPLC method) of these antioxidants from the cheese matrix. Also, **Rashidinejad *et al.* (2016a)** showed that the fortificated full-fat cheese with free green tea extract significantly raised the antioxidant activities in the cheese on day one as well as over ripening. All ethanolic extracts from peanut skins, potato peels and rice bran as natural antioxidant revealed lowest PV compared with control (A) and (B) during storage period up to 90 days. These results agree with some studies of natural antioxidant such as Potato peels (**Sotillo *et al.*, 1994 a,b**) rosemary and oregano (**Santos and Shetty, 2012**), ginger (**Abdel-Aziz *et al.*, 2012**) and catechin (**Rashidinejad *et al.*, 2016b**).

## Thiobarbituric Acid (TBA) Value

It is well known that TBA test is taken as an indication to evaluate the advance of oxidation changes occurred in oil and fat. The addition of natural antioxidant to cheese retarded the oxidative changes during storage. This means that the formation of malonaldehyde, which effect the formation of pink colour. The formation of malonaldehyde took place at a relatively lower rate in the cheese containing natural antioxidants. It seems that there is a relationship between the antioxidant efficiency and both type and the percentage of natural antioxidants which can be used as oxidation inhibitors.

Results in Table 6 illustrate the effect of adding ethanolic extracts of peanut skins, potato peels and rice bran at the rate of 0.5 or 1% on TBA values of white soft cheese during storage up to 90 days. Results revealed that TBA values in control cheese without antioxidant (A) was significantly higher ($P \geq 0.05$) than cheese contained BHA (0.02%) as positive control (B). Cheese samples containing ethanolic extracts concentration 0.5 or 1% of peanut skins, potato peels and rice bran as natural antioxidants had significantly ($P \geq 0.05$) lower TBA values when compared with control cheese (A and B) up to 90 days. This means that ethanolic extract of natural antioxidant had high efficient antioxidative than synthetic antioxidant. Cheese samples containing ethanolic extracts of peanut skins were more active than potato peels or rice bran in this respect.

These results are in accordance with the results of **Modaly *et al.* (2010)** who found that sunflower oil and soybean oil, treated with potato peel and sugar beet pulp extracts were more active than butylated hydroxyl toluene (BHT).

Also, these results also are in accordance with that obtained by **Iqbal and Bhanger (2007)** and **Iqbal *et al.* (2008)** who decided that the addition of garlic and pomegranate peel extracts at high concentration had protective effects against oxidation of sunflower oil. The results of the current study showed that, by increasing the extracts concentration, the TBA values decreased. The inhibitory effect of extracts was similar of the beginning of the storage period and increased gradually as storage period progressed. Also **Goufo and Trindade (2014)** reported that rice bran is a good source of phenolic compounds.

## Acid Value (AV)

Table 6 shows clearly that there were significant differences between cheese treatments during storage. It is obvious from these results that cheese containing ethanloic peanut skins showed lower increase in acid values compared with other cheese samples containing natural antioxidant extracts and also control without antioxidants (A) and control with BHA (B). Referring to the high effect of peanut skins extract in delaying fat hydrolysis, this may be due to its high content of phenolic compounds. These results are in accordance with (**Wang *et al.*, 2007**).

In all cheese samples the AV increased gradually as storage period progressed. Control cheese (A) and without BHA was significantly ($P \geq 0.05$) had higher AV compared with all experimental cheese during storage up to 90 days. This may be attributed to the fat hydrolysis and liberation of free fatty acids, which cause gradual increase in rancidity during ripenin.

From these results it could be observed that the most effective extracts in this respect was that showed the lowest values for PV, TBA and AV levels. Similar result were reported by **Abdel-Aziz *et al.* (2012)** and **Bardruina *et al.* (2013)**.

Table 7 shows the percentage of antioxidant effectiveness (AE%) of BHA and NAEE of white soft cheese during storage.

It is clear that the differences in NAEE effectiveness (AE%) could be attributed to the amount of phenolic compounds of different plant by-product used. These results are in agreement with those reported by **Prakaska *et al.* (2001)** who found that the variation in the extraction yields of different extracts may be refer to differences in polarity of compounds found in plants used. The same Table shows that the percentage of natural antioxidant effectiveness (AE%) of NAEE were higher than BHA added. Also; it is clear that (AE%) of peanut skins was higher than both potato peels and rice bran. These results are in agreement with **Yen *et al.* (1993)** who reported that peanut hulls exhibited marked antioxidant activity as a result of containing a considerable amount of phenolic compounds, which retard fat rancidity. Also, results are in accordance with **Pankaj *et al.* (2013)** who found that the ethanolic extract of *T. arjuna bark* at 7% by the weigh was highly effective in retarding fat out-oxidation of both cow and buffalo's ghee during storage, also they found that ethanotic extract of *Arijuna* had significant ability to enhance the antioxidation potential of ghee.

Generally, the results showed that natural antioxidant extracts had the ability to retarding of fat oxidation than synthetic antioxidant during storage.

## Microbiological Examination

It is clear from Table 8 that all the tested ethanolic extracts as natural anti-oxidants showed also anti-microbial activity of the resultant cheese up to 90 days.

The anti-bacterial activity of peanut skin (0.5 and 1%) extracts exhibited the maximum microbial inhibitor compared with control (A and B). On the other hand, *E. coli* disappeared from cheese made with NAEE and control with BHA after 30 days.

The ethanolic extract of peanut skins showed the highest microbial inhibition followed by potato peels and then rice bran.

The differences in level of effectiveness between all samples containing natural antioxidant extracts might be due to the ability of phenolic compounds to bind with bacterial cell walls and prevent all division and growth (**Cowan, 1999; El-Sohaimy, 2014**).

The presented results in Table 8 encourage the using ethanolic extracts of peanut skins, potato peals and rice bran in white soft cheese making, which gave the best anti-microbial activity, than that treated with synthetic antioxidant during storage period. These results are in agreement with that reported by **Sotillo *et al.* (1998)** who found that potato peals extract demonstrate anti-bacterial activity against *E. coli* and *S. typhimorium*, and also, agree with **Azzam (2007)** who showed that the antioxidant from ginger extract had a high activity effect of antioxidant and antimicrobial.

## Yeasts and Molds

Results present in Table 8 show the difference in yeast and mauled count of white soft cheese. It is clear from this Table that yeast and moulds increased gradually in cheese without antioxidant control (A) throughout till the end of the storage period. But they disappeared at 60 days in cheese fortified with NAEE compared with cheese fortified with BHA (B). The highest account number was observed in control cheese made without any antioxidants throughout the storage compared with all treatment during ripening. These results are in agreement with those obtained by **Masibo and He (2004), Azzam (2007), Jin (2009)** and **Morteza *et al.* (2012)**, they found that cheese fortified with plant leaves extract reduced yeast and molds counts and this may be due to anti-microbial and anti-fungal activity. Also the general trend of these results agree with these reported by **Al-Jasser and Al-Dogan (2009), Yu *et al.* (2010)** and **Barduina *et al.* (2013)**.

**Table 7. The percentage of antioxidant effectiveness (AE %) of white soft cheese treated with natural and synthetic antioxidant (BHA) during storage at room temperature**

| Property | Storage period (day) | Soft cheese made with natural antioxidant ethanolic extract (NAEE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Control | | Rice bran | | Potato peel | | Peanut skin | |
| | | Without antioxidant | With BHA (0.02%) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% |
| Peroxide values (meq/kg) | 0 | - | 8.75 | 12.50 | 18.33 | 13.13 | 19.79 | 13.96 | 21.88 |
| | 30 | - | 9.48 | 12.72 | 18.64 | 13.25 | 20.04 | 14.22 | 22.41 |
| | 60 | - | 11.77 | 14.93 | 21.05 | 16.03 | 22.79 | 17.28 | 24.04 |
| | 90 | - | 24.48 | 37.24 | 42.19 | 37.81 | 42.71 | 38.80 | 43.65 |
| Thiobarbituric acid (TBA) (OD at 352 nm) | 0 | - | 8.49 | 11.52 | 18. 18 | 12.73 | 20.61 | 14.55 | 22.42 |
| | 30 | - | 8.72 | 12.79 | 18.60 | 13.37 | 20.93 | 15.70 | 24.42 |
| | 60 | - | 9.56 | 14.78 | 20.87 | 15.65 | 21.74 | 17.39 | 24.78 |
| | 90 | - | 22.86 | 22.86 | 35.41 | 37.43 | 43.14 | 38.57 | 44.29 |
| Acid values (mg KOH/g) | 0 | - | 6.25 | 6.25 | 8.75 | 11.25 | 18.75 | 12.50 | 21 25 |
| | 30 | - | 8.26 | 8.26 | 11.92 | 12.84 | 20.18 | 13.76 | 22.02 |
| | 60 | - | 8.46 | 8.46 | 12.31 | 13.85 | 20.77 | 15.84 | 23.08 |
| | 90 | - | 19.87 | 19.87 | 21.15 | 22.44 | 26.92 | 23.08 | 27.56 |

**Table 8. Microbiological examination of white soft cheese as affected by adding different levels of some natural antioxidants during storage at room temperature**

| Property | Storage period (day) | Soft cheese made with natural antioxidant ethanolic extract(NAEE) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Control | | Rice bran | | Potato peel | | Peanut skin | |
| | | Without antioxidant | With BHA (0.02%) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% |
| Total count (cfu/g) $10^4$ | 0 | 52 | 45 | 12 | 16 | 14 | 9 | 18 | 16 |
| | 30 | 30 | 20 | 7 | 3 | 12 | 6 | 12 | 12 |
| | 60 | 13 | 12 | 2 | 0.96 | 8 | 2 | 4 | 4 |
| | 90 | 12 | 4 | 2 | 0.92 | 0.92 | 0.90 | 3 | 1 |
| *E. coli* count (cfu/g) $10^1$ | 0 | 2 | 5 | 2 | 3 | 5 | 2 | 4 | 4 |
| | 30 | 5 | 3 | ND | ND | 3 | 2 | 3 | 2 |
| | 60 | 2 | ND | ND | ND | ND | ND | ND | ND |
| | 90 | ND | ND | ND | ND | ND | ND | ND | ND |
| Yeast and Moulds (cfu/g)$10^1$ | 0 | 2 | ND | ND | ND | ND | ND | ND | ND |
| | 30 | 8 | ND | ND | ND | ND | ND | ND | ND |
| | 60 | 8 | ND | ND | ND | ND | ND | ND | ND |
| | 90 | 32 | 20 | 8 | ND | 4 | ND | 12 | ND |

ND : Not detected

## Sensory Evaluation

Results in Table 9 show the average score points given for appearance, body and texture and flavour of white soft cheese as affected by adding natural antioxidant extracts. These results showed that there were significant differences between the control without any antioxidant or with BHA and all experimental cheese fortified with NAEE when fresh and during ripening period up to 90 days. All treated samples recorded significant differences ($p \geq 0.05$) at the rate of (0.05 or 1%) of natural antioxidant extracts, on the overall sensory quality when compared with control without any antioxidant or with BHA. It is clear from these results that cheese sample with potato peals and rice bran and peanut skin extracts at rate 1% was the most accepted reaching an acceptance index (96.92% and 92.67%), respectively up to 90 days, while cheese treated with 1% extract of peanut skins was 90.25 at 90 days.

In spite of cheese contained peanut extracts was significantly higher for retarding fat oxidation (fat rancidity), but it showed the lowest score for appearance, these may be due to its undesirable reddish colour of these extracts, which influenced on the colour degree of the resultant cheese. On the other hand, all cheeses contained natural antioxidant extracts were accepted by panelists. Also, all natural antioxidant improved cheese properties and overall acceptability until the end of storage period, these results are in agreement with these obtained by **Azzam (2007)**. Also, these results are in accordance with **Adesokan *et al.* (2010)** who found that natural anti-oxidant extracts from ginger can also enhance and improve cheese shelf life because of its anti-microbial and antioxidant nature.

Finally it was quite clear that cheese treated with different natural antioxidant extracts lead to reduce the undesirable changes compared with control without or with BHA up to 90 day. This means that the treatment of cheese samples contained NAEE kept the organoleptic properties in good state and expanded its shelf life of the resultant cheese during ripening.

**Table 9. Organoleptic properties of white soft cheese as affected by adding different levels of some natural antioxidants during storage at room temperature**

| Storage period (day) | Property | | Soft cheese made with natural antioxidant ethanolic extract (NAEE) | | | | | | | | LSD | Significant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Control | | Rice bran | | Potato peel | | Peanut skin | | | |
| | | | Without antioxidant | With BHA (0.02%) | 0.5% | 1% | 0.5% | 1% | 0.5% | 1% | | |
| 0 | Appearance | 10 | 7.70 | 7.60 | 8.00 | 7.67 | 7.00 | 8.33 | 7.50 | 7.67 | | |
| | Body and texture | 40 | 36.90 | 36.85 | 36.90 | 36.90 | 36.90 | 38.67 | 36.85 | 36.90 | | |
| | Flavour | 50 | 40.90 | 40.65 | 39.67 | 41.00 | 40.67 | 43.67 | 40.90 | 41.00 | | |
| | Total | 100 | 85.57$^{b}$ | 85.10$^{b}$ | 84.57$^{c}$ | 85.57$^{b}$ | 83.90$^{d}$ | 90.97$^{a}$ | 84.35$^{c}$ | 85.57$^{b}$ | 0.368 | *** |
| 30 | Appearance | 10 | 7.82 | 7.64 | 8.66 | 8.33 | 7.65 | 8.67 | 7.65 | 8.37 | | |
| | Body and texture | 40 | 36.80 | 336.60 | 36.85 | 36.67 | 36.95 | 37.65 | 36.80 | 36.70 | | |
| | Flavour | 50 | 40.95 | 41.34 | 41.67 | 42.65 | 42.00 | 44.67 | 41.55 | 42.16 | | |
| | Total | 100 | 85.57$^{f}$ | 85.98$^{e}$ | 87.18$^{c}$ | 87.65$^{b}$ | 86.60$^{d}$ | 90.99$^{a}$ | 86.00$^{e}$ | 87.23$^{c}$ | 0.252 | *** |
| 60 | Appearance | 10 | 7.90 | 7.75 | 8.67 | 8.40 | 7.80 | 9.33 | 7.76 | 8.60 | | |
| | Body and texture | 40 | 36.40 | 36.10 | 36.10 | 36.10 | 36.80 | 38.60 | 36.40 | 36.50 | | |
| | Flavour | 50 | 41.95 | 41.90 | 42.00 | 44.35 | 43.33 | 46.33 | 41.95 | 43.57 | | |
| | Total | 100 | 86.25$^{e}$ | 85.75$^{f}$ | 86.86$^{d}$ | 88.85$^{b}$ | 87.93$^{c}$ | 94.26$^{a}$ | 86.11$^{e}$ | 88.67$^{b}$ | 0.215 | *** |
| 90 | Appearance | 10 | 7.95 | 7.79 | 9.00 | 8.60 | 7.85 | 9.75 | 7.80 | 8.70 | | |
| | Body and texture | 40 | 36.20 | 36.00 | 36.00 | 37.40 | 36.50 | 38.50 | 36.20 | 36.75 | | |
| | Flavour | 50 | 42.50 | 42.00 | 42.35 | 46.67 | 45.67 | 48.67 | 42.75 | 45.80 | | |
| | Total | 100 | 86.65$^{f}$ | 85.79$^{g}$ | 87.35$^{e}$ | 92.67$^{b}$ | 90.02$^{d}$ | 96.92$^{a}$ | 86.75$^{f}$ | 90.25$^{c}$ | 0.207 | *** |

Means with the same letter are not significantly different NS : Non significant ** : High significant
***: very high significant LSD : Least significant difference at ($P \geq 0.05$)

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# إنتاج الجبن الأبيض الطري المدعم بمضادات الأكسدة الطبيعية كغذاء لبني وظيفي

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أجريت هذه الدراسة بهدف تقدير النشاط المضاد للأكسدة ومحتوى المواد الفينولية لمستخلصات الكحولية لكلا من سرس الأرز، قشور البطاطس وقشور الفول السوداني (قشرة البذرة) ودراسة تأثير اضافة هذه المستخلصات الطبيعية على جودة الجبن الأبيض الطري، حيث تم إضافة هذه المستخلصات كلا على حده عند صناعة الجبن الابيض الطري بمعدل ٠,٥ إلى ١ %، وتم تحليل الجبن من حيث التركيب الكيماوي، الثبات ضد الأكسدة، الفحص الميكروبيولوجي والخواص الحسية وذلك بعد التصنيع مباشرة وبعد مرور ٣٠و٦٠ و٩٠يوما من التخزين على درجة حرارة الغرفة وقد أوضحت النتائج أن هذه المستخلصات بها محتوى عالى من المواد الفينولية وأعطت نشاط عالي كمضاد للأكسدة، كذلك وجد أن إضافة هذه المستخلصات إلى الجبن لم تؤثر بشكل ملحوظ على التركيب الكيماوى ولكنها أثرت على الثبات ضد الأكسدة والفحص الميكروبيولوجي والخواص الحسية لعينات الجبن، حيث لوحظ انخفاض واضح فى قيم رقم البيروكسيد ورقم الحموضة وحمض الثيوباربتيوريك في عينات الجبن المحتوية على مستخلصات مضادات الأكسدة الطبيعية وذلك خلال فترة التخزين مقارنة بجبن الكنترول المصنع بدون إضافة مواد مضادة للأكسدة (كنترول A)، وكذا عينات الجبن المحتوية على ٠,٠٢% من مضادات الأكسدة الصناعية البيوتيليتيد هيدروكسى انيسول ككنترول آخر (B) وكان أكثر المستخلصات نشاطا مستلخص قشور الفول السودانى، قشر البطاطس ثم سرس الأرز على التوالى، ومن حيث الخواص الميكروبيولوجية لوحظ انخفاض فى اعداد البكتريا الكلية وبكتيريا الكوليفورم والفطريات والخمائر فى عينات الجبن المحتوية على المستخلصات الطبيعية وذلك خلال فترة التخزين عن عينات جبن المقارنة وتلك المحتوية على مضادات أكسدة صناعية (BHA)، ومن حيث الاختبارات الحسية فان عينات الجبن المحتوية على المستخلصات الطبيعية أعطت أعلى معدل تحكيم حسى عن باقى المعاملات وذلك خلال فترة التخزين فيما عدا العينات المحتوية على مستخلص قشورالفول السودانى بخصوص اللون حيث أعطي لون مائل للون الأحمر الطوبى مما قلل من درجة القابليه جزئيا للمظهر الخارجي للجبن الناتج، ومن خلال النتائج السابقة فانه يمكن استخدام بعض المستخلصات الطبيعية فى صناعة الجبن الطرى الأبيض مثل مستخلص قشور البطاطس وسرس الأرز وقشور الفول السودانى بمعدل ١% حيث أنها حسنت من الخواص الحسية، والميكروبيووجية لعينات الجبن وزادت من ثباتها ضد الأكسدة خلال فتره التخزين حتى ٩٠ يوما.

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