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Effect of microwave roasting on the oxidative stability and physicochemical properties of sesame seeds (Sesamum indicum)

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ABSTRACT: The effect of microwave radiation on sesame quality was investigated. Effects of microwave treatment on the quality of sesame seeds were assessed. Survey of the roasting temperature and time effects on water content, dry matter, antioxidants activit , phenolic, flavonoids, sugar and protein content in sesame seeds was the aim of this investigation,quality of sesame seeds changed during roasting compared to the unroasted sesame seeds, The optimum roasting time on microwave oven to obtain the most antioxidants and total phenolic, flavonoids and other contents was 9 minutes, this period stimulates the concentrations of the bioactive compounds which influence the antioxidant activity.

KEYWORDS: Antioxidant activity, Phenolic, Flavonoids, Sugar, Protein, Microwave

I. INTRODUCTION

We explored in this study the incidence of microwave treatment on the quality of sesame seeds until packaging for reduce the thermo tolerance of some bacterial strain. Microwave technology is increasingly playing an important role in drying in the food industry because of its rapid heating rate and ease of use. It also shows considerable potential for preventing mildew in food. In addition, this method of processing does not cause environmental pollution of introduce chemical reagents. Microwave heating of foods is also an efficient method capable of generating energy inside the product through the interaction of radiation, mainly with water molecules. Microwaves are applied to different processes showing some advantages such as reduction of the environmental impact, energy saving compared to conventional methods, use of clean energy, spatial savings and decreasing of processing times [1].

Microwave are a non-ionizing energy that can generate heat deep inside the penetrated medium by the molecular friction in an alternating electromagnetic field [2], Recent studies on pest or mildew control of agricultural products such as rice have reported that microwave treatment is a potential means of remplacing chemical fumigation in pest control [3]. Since it is quite competitive in cost compared to other methods of heating, it has been used for thawing of frozen foods, drying, baking, rendering, pasteurization, and sterilization. Although microwave treatment causes less thermal damage to the test material than general heating methods such as hot water heating, it causes biochemical reactions and changes the molecular conformation of starch and protein, texture, and physicochemical properties such as gelatin temperature of food products [4]. Also, the utilization of microwave heating in house hold, restaurants and fast food preparation is rapidly increasing because of its swiftness, ease of operation, and cost benefits. Microwave radiation penetrates to the internal parts of the food. However, there are speculations on the ease of free radical formation when fatty foods are exposed to microwave energy resulting in production of objectionable compounds in

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microwave-cooked foods, the process of microwave is commonly found in both domestic and food catering operations and is very popular for high speed and convenience, as compared to conventional heating treatments [5]. Microwaves are very popular for high speed and convenience, as compared to conventional heating treatments. Their effects on macro and micro components as well as flavor formation and color changes in several foods, have been extensively evaluated. The influence of microwave heating on the thermo-oxidative stability of different products in households was also investigated; different vegetable seed oils subjected to various heating times and microwave powers exhibited the formation of reactive free radicals that rapidly reacted with the atmospheric oxygen to produce hydroperoxides and secondary oxidation products [6]. Microwave heating has been reported to provide superior quality fruit-based products with an extended shelf-life, representing a good alternative to conventional preservation processes, Given the particular way of heating which takes place during microwave processing (volumetric heating), this technology leads to higher penetrative power, faster heating rates, higher thermal efficiency and shorter processing times compared to conventional heating methods. All these facts seem to result in better organoleptic, nutritional and functional properties preservation, with a particular effect on color.

Some reports suggest that nutrient retention, phenolic compounds and vitamins in microwave foods, is improved because roasting time is shortened [7], however, other researchers indicate that nutrient retention in microwave processing in not much greater than that in conventional cooking [8], until now, there has been no information on how microwave roasting affects, not only the oxidative stability, but also the distribution of phenolic compounds in seeds.

Sesame is one of the most edible oil seeds, had also been used throughout East Africa where it is mainly grown for grain and oil, The chemical composition of sesame shows that the seed is an important source of oil (44-58%), protein (18-25%), carbohydrate (~13.5%) and ash (~5%). The oil fraction shows a remarkable stability to oxidation [9], it has been used in different forms; paste powder, Tahina, but those by-products were obtained by roasting the sesame seeds by conventional roasting or other process, it has been shown that roasting can increase the total phenolic and antioxidants activity [9].

In this study, we treated sesame seeds using a microwave oven with the objective of investigating the effects of microwave treatment on the quality of sesame seeds when roasted for different time periods.

II. MATERIALS AND METHODS

A. Chemicals and reagents:

The solvents and the chemicals used were of analytical grade, ethanol and distilled water were used as solvent for extraction of antioxidants compounds. DPPH, Na2CO3, Folin-Ciocalteu, gallic acid, aluminium trichlorid, quercetin, phenol, sulphiric acid, Bradford were stored at prescribed conditions in the laboratory.

B. Sesame seeds roasting:

Sesame seeds were roasted using a microwave oven for 25 min. During roasting process samples were taken at different time intervals (1,3,5,7,9,11,13,15,17,19,21,23,25 min), and they were immediately equilibrated to room temperature to prevent further heating, Therefore 14 roasting conditions were used in this study, roasted seeds were packed in polyethylene plastics bags and stored for analysis.

C. Analytical methods:

Dry matter:

The dry matter of the cultivars was determined by oven drying at 105°C to constant weight [10].

Soluble sugars:

Sugars were extracted with ethanol (80%) by centrifuged for 40 min. After the centrifugation, the supernatant was collected and the sugar content was analyses with phenol/ sulphuric reagent [11].

Proteins:

Total protein was determined by the method described [12]. Protein was extracted with phosphate buffer. After centrifugation, the supernatant was collected and the protein content was analyzed with the Bradford reagent.

D. Assessment of Bioactive Activity

Preparation of Seed Extracts

The seeds of each cultivar were ground in the mixer separately. 10g of the powder was weighed and suspended in 100ml of 90% ethanol and kept for shaking for 2 hours. After filtration, the samples were subjected for vacuum

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evaporation. The extract was redissolved in a 2 ml of 90% ethanol and assayed for its antioxidant activity, phenolic content, flavonoids and flavonols [13].

DPPH Radical Scavenging Activity

For determination of the antioxidant activity of sesame extracts, the stable, 1 diphenyl-2-picryl hydrazyl (DPPH) radical was used [14]. An aliquot 0.5ml of DPPH solution was diluted in 4.5 ml of methanol, and 30µl of ethanolic solution sesame extract was added. A control without extract was also maintained. The mixture was shaken vigorously and allowed to stand for 45 minutes in the dark and the absorbance was measured at 515nm. The antioxidant activity of the extract was calculated using the formula,

% scavenging activity= ((Absorbance sample – Absorbance control) / Absorbance control) X 100.

Total Phenolic Content

The amount of total phenolic compounds was measured using the method [15]; 15mg of extract was dissolved in 1ml of 90% ethanol. A 10µl aliquot of the resulting solution was added to 2ml of 2% Na2CO3 and after 2 minutes 100µl of Folin-ciocalteu reagent (diluted with water 1:1) was added. After a further 30 minutes, the absorbance was measured at 750nm. The concentration was calculated using gallic acid as standard, and the results were expressed as mg gallic acid equivalents per mg extract.

Total Flavonoid Content

The flavonoid content was determined using the method [16]; 1ml of the extract was added to 1ml of aluminium trichlorid ALCL3 (2%).After 15 min of incubation. The absorbance was measured at 430 nm and the results were expressed an mg quercetin equivalents per mg extract.

E. Statistical Analysis:

Statistical analyses were conducted using SPSS (Statistical Program for Social sciences) version 17.0 for window. All analyses were performed in triplicate and data reported as means ± standard deviation (SD).

III. RESULTS AND DISCUSSION

The quality of control and microwave treated sesame were compared; the internal temperature of the sesame seeds at the end of each roasting period was compared, the temperature of the seeds was 25°C before microwave treatment and increased to 130,6 °C at 25 min of roasting. Water content decreased with an increase in microwave time leading to water evaporation witch cause an increase in the dry matter with the values ranging between 95,29 % for the unroasted sample and 98,22 % for the sample roasted for 25 min. This result is in agreement with the water activity with the values of 4,71 and 1,78 %,Fig (1),Fig (2)

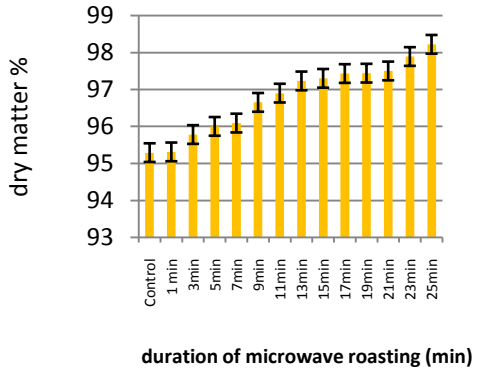

Fig.1 Effect of microwave roasting on sesame seeds On the dry matter %

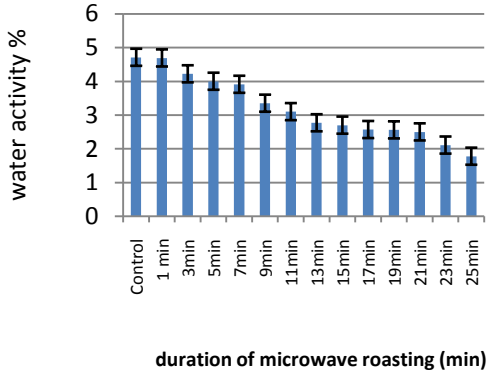

Fig .2 Effect of microwave roasting on sesame seeds on water activity %

Fig 3. Shows that microwave treated sesame seeds were higher in protein content that untreated one for all the samples from the 25 min of roasting, the protein values were ranging between 25,15 g/100g for the unroasted sample and 28,9g/100g for the sample roasted for 25 min the protein content increase as a result of a increase in the content of –SH during process, which prove that microwave roasting for 25 min can raise the quality of sesame seeds, but It was

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reported also that with further roasting time, the protein can be decomposed or get cross reactions at the level of essential amino-acid, which causes a decrease in nutritional quality of protein, the vitamins also undergo oxidative degradation, forming reactive compounds which react again with protein in the Maillard reaction and the roasting process much longer affects also the ability of polyphenols to interact with protein, causing a decrease in astringency [17].

Fig.4 illustrates the fact that the total sugar content of the sesame seeds increase for the first 9 min to rush 0,38g/100g compared to the unroasted sample with the value 0,36 g/100g, but after the 11min, the sugar content start to decrease until arrive to the value 0,32g/100g, which causes a change in the color of the seeds which explain why the sugar content considered as indirect measure of the concentration of the substrate of non- enzymatic browning reactions or of the nutrients remaining after the browning reactions [18], These results suggest that higher temperature and longer roasting times in microwave should not be used in the roasting of sesame seeds, because many nutrients, are degraded in the non-enzymatic browning reactions during the roasting process [18].

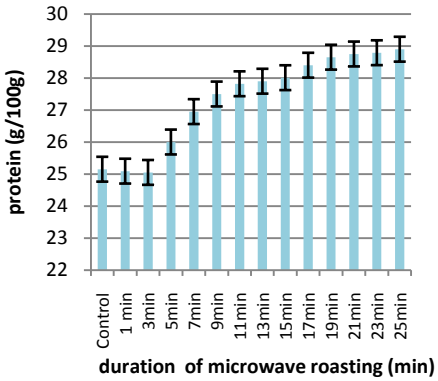

Fig .3 Effect of microwave roasting on sesame seeds on On the protein content (g/100g)

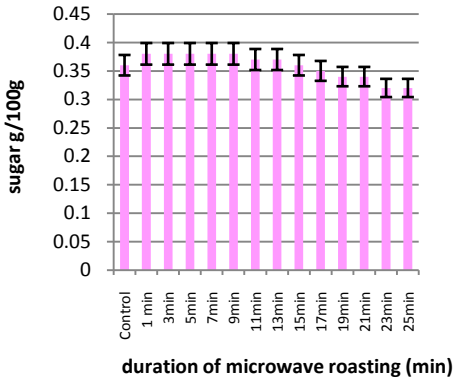

Fig .4 Effect of microwave roasting on sesame seeds on on the sugar content (g/100g)

With increased microwave roasting time, a significant loss ($P<0,05$) was apparent in the sugar content , these trends become more pronounced after 9 min of roasting.

The phenolic content was determined by using Folin-Ciocalteu reagent. Folin-Ciocalteu reagent nonspecifically with phenolic compounds as it can be reduced by a number of non phenolic compounds. Although exact reaction of the reagent with reducing species in not known, but it is considered that a complex is formed between phosphor-mobybdic tungstate and reducing species, phenol ate ion, changing color from yellow to blue.

The amount of phenolic and flavonoids contents were determinate in different time of microwave roasting, the contents phenolics ranging between 3,95mg/g for the unroasted sample and 2,9mg/g for the roasted one and for the flavonoids content, ranging between 0,13mg/g for the unroasted sample and 0,1mg/g for the roasted one for 25 min which means they are differed significantly ($P<0,05$) (Fig .5),(Fig.6).

Several studies showed good correlation between the total phenols and antioxidants activity.

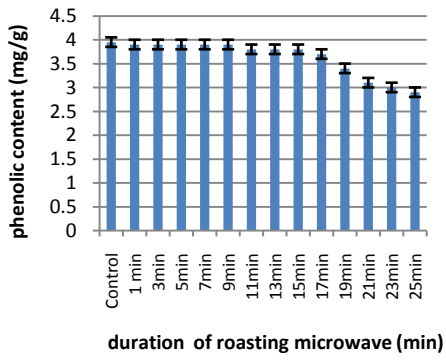

Fig .5 Effect of microwave roasting on sesame seeds on On the phenolic content (mg/g)

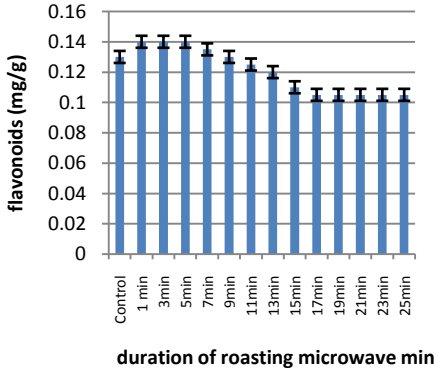

Fig .6 Effect of microwave roasting on sesame seeds on on the flavonoids content (mg/g)

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For the antioxidant activity; using DPPH radical, the free radical scavenging ability of the sesame seeds extracts was evaluated considering that DPPH radical is commonly used for the assessment of antioxidant activity in vitro and is foreign to biological systems, DPPH is a very stable organic free radical with deep violet color which gives absorption maxima within 515-528 nm range. Upon receiving proton from any hydrogen donor, mainly from phenolics, it loses it chromophore and become yellow. As the concentration of phenolic compounds or degree of hydroxylation of the phenolic compounds increases their DPPH radical scavenging activity also increases, and can be defined as antioxidant activity [19]. Because these radicals are very sensitive to the presence of hydrogen donors, the whole system operates at very low concentrations; with it, it can allow a large number of samples to be tested in a short time. Absorbance in this assay was recorded at 45min from the initiation of the reaction. Observed scavenging activity was similar at the beginning of the reaction until arrive to 7 minutes with the value 65% for the unroasted sample and 65,3% for the sample after 7 min, the value increase lightly and then decrease until arrive to 50 % in the minute 25 (Fig.7). So, the results indicate that antioxidant activity of sesame extracts was significantly affected by roasting temperature in microwave oven, to obtain the highest antioxidant activity and total phenolic content, sesame seeds should be roasted for 9 minutes in microwave.

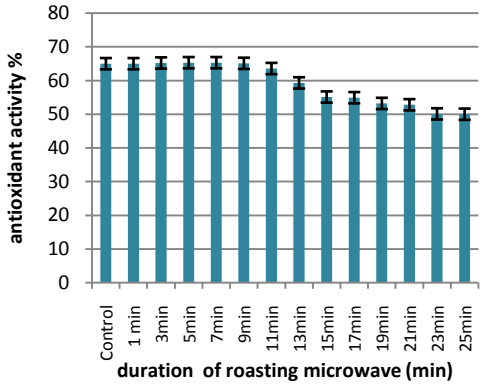

Fig .7 Effect of microwave roasting on sesame seeds on the oxidative stability

Relationship between the results of antioxidant activity and phenolic compounds was established by correlation analysis; antioxidant activity of this compound is often associated with their redox properties, which allow them to act as antioxidative agents. The results shows that the phenolic compounds well correlated with DPPH radical scavenging activity (R=0,897), (P<0,05), also the antioxidant activity showed good correlation with the flavonoids compounds with (R=0,887),(P<0,05), Overall, correlation analysis indicated that results of three repetition used in this study were correlated with each other, verifying that antioxidant activity of the plant extracts is mainly dependant on the amount of total phenolics.

VI .CONCLUSION

In conclusion, the results indicate that the roasting in microwave of the sesame seeds for 9 minutes showed the best antioxidant activity , phenolic compounds and sugar content, as for the protein, greater quantity can be achieved by microwave treatment for 25 °C. Sesame has been considered a valuable oil-seed, not only because of its high oil and protein content, but also for his utilization for different by-product, for its valuable components which contribute in nutritional and functional food for humans, sesame seeds can attract consumers and processors for value-based food products.

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