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FULL PAPER

The impact of ozone gas treatment on the amylose/amylopectin ratio in Iraqi jasmine rice grains

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The ratio of amylose to amylopectin has a significant impact on rice cooking properties. The raw rice grains with moisture levels of 14% and 18% were treated with 30 mg/L ozone for 5 hours and the milled rice was treated for 3 hours, as well. The sample weighed 2 kg and the treatment was carried out in a confined space system with the ozone-mixed air being pushed through it in which amylose was assessed to be 18.93% and amylopectin to be 81.07%. The percentages of amylose and amylopectin in ozone-treated versus non-ozone-treated grains did not change significantly, for both raw and milled rice, at both moisture content and ozone treatment levels. To extend the storage life, the ozone treatment period for raw and milled rice was determined based on the removal of most microorganisms.

KEYWORDS

Treatment; ozone; jasmine rice; amylose; amylopectin.

Introduction

The rice grain (*Oryza sativa* L.) is a major food crop. It has been a staple meal in many Asian countries since the ancient times, along with wheat and corn [12]. More over half of the world's population is fed on rice and it plays a critical part in satisfying the growing need for grain as the world's population growth. The amount of rice produced in Iraq was 574,705 tons [4]. One of the most important uses of ozone in agriculture is crop postharvest treatment [20]. The effectiveness of ozone is dependent on a number of parameters, including the used concentration, the qualities of each meal and the ambient conditions like temperature and humidity. Due to the physical structures that come into touch with the gas, each ozone-treated food, such as rice, wheat, or nuts, may behave differently. Consequently, the extensive research are required to better understand its usefulness [5,16]. Ozone is a powerful oxidant that has a wide range of uses in the food industry. Ozone has been used to decontaminate foods such as fruits, vegetables, spices, herbs, drinks, meat, and fish in both gaseous and aqueous forms. In the food processing industry, the ozone processing is one of the most promising non-thermal and bio-friendly procedures. Because of its antibacterial characteristics and potential to change the functional aspects of foods, ozone technology is being more widely used in the food business. The starch structural alterations offer a variety of applications in the food and baking industries, including longer shelf life, better texture, and moisture retention. The viscosity of starch molecules is altered by the positive reaction of ozonation in carboxyl and carbonyl groups [10]. The advantage of utilizing ozone is that it decomposes quickly converting carbon dioxide into oxygen in the air, leaving fewer residues in the product and obviating the need for removing gas. Ozone is the most promising green technology for improving food safety and quality since it has non-residual qualities and it is an environmentally beneficial solution [10,11]. It's also been given the "Generally Recognized as Safe" designation (GRAS) for food matrix disinfection [8]. The consumer's desire to take rice is mostly determined by its ultimate cooked texture. Following cooking, various rice kinds have varied the textures. The ultimate texture of cooked rice is determined by starch, which is the major component of rice. The amylose concentration and gelatinization temperature are determined by the starch properties [9,3]. Rice texture is an important sensory element in assessing the eating quality of cooked rice. Hardness and stickiness are the two most important factors which influence rice texture and its eating quality. [13]. A variety of factors influence the texture of cooked rice, including amylose content, post-harvest processing, and cooking method. The most important characteristic is that the amylose level has an impact on the final texture of cooked rice. The structure of amylopectin is considered to determine texture. Regarding its lengthy chain, the ultimate texture of cooked rice is determined by the amylopectin chains [6].

Materials and methods

Sample collection

Random samples was taken from raw rice, Iraqi jasmine variety, harvested in the 2020 season, as stated in (2010) AACC 64-70.02 from the receiving sites of the General Company for Grain Trade of the Ministry of Trade/sites (Babylon, Najaf, and Diwaniyah) drawn by the employees of the receiving sites by 14% of the acceptable moisture content and 18% of the rejected moisture.

Grinding and polishing

A crushing device was used SATAKE RICE MACHINE HUSKER (Type THU, 35A), weighing 250 g of the refined raw rice and is placed in the upper feeding slot where it is closed, then the device is turned on and after that, the feed slot is opened gradually for the passage of the grains through the rolls of the crushing after adjusting them according to the type of grains (i.e. it is essential that the grains passes smoothly). The brown rice is collected in one of the two lower boxes and the quantity is crushed again to obtain the largest amount of brown rice.

A bolishing device was used SATAKE [Testing Mill TM05C]. 200 g of brown rice was weighted and placed it in the upper tank, with the door to the tank was closed. Then, the brown rice grains were passed over the disc stone and the sieve, and it was divided into bleached rice and bran. The device is equipped with a watch timing to determine the appropriate time to reach the required degree of whiteness. Timing was set to 45 seconds in order to reach the degree of whiteness of the milled rice grains to 32 degrees for the control sample T1 according to the Iraqi Standard No. IQS 1343/2019 for rice was issued by the Central Organization for Standardization and Quality Control.

Ozone treatment

An ozone treatment system was made by the researcher consisting of the ozone device from Laisen Electronic Devices Company of Chinese origin by the method of the electric charging (Charging) with a pumping capacity of 10 g/hour and a flow speed of 5-7 liters/min. The device worked by pumping air (input) and it passed through a purification processor made of aluminum, from which an air stream was formed in a glass insulator between two parallel electrodes and as a result of the high voltages of the device, the oxygen molecule was broken and the atoms were re-formed in a triple (O3) form and a stream of generated gas was pumped through an output tube (output) and went to a cylindrical container of Acrylonitrile Butadiene Styrene (ABS), 10 cm in diameter and 50 cm in height, with the air flow meter, stainless steel clamp, and plastic connecting tubes made of Polyvinylidene Difluoride, sample weight for all treatments 2 kg were placed in the above-mentioned cylindrical container and the flow velocity was adjusted by an air flow meter to 5.5 L/min and the used concentration was 30 mg/L, as depicted in Figure 1.

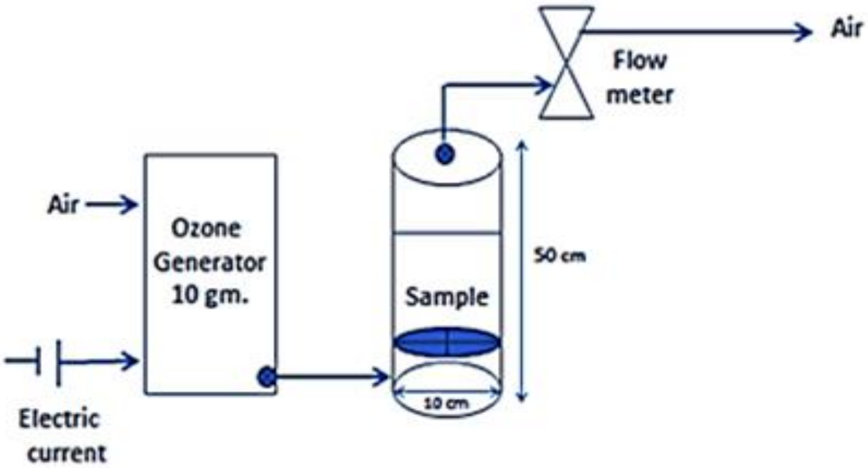

FIGURE 1 Plan–Ozone system for sterilization of rice grains

The raw rice samples (i.e. moisture content 14% and 18%) were for 5 hours, they were exposed to ozone gas at a dosage of 30 mg/L.

The treatments after grinding and polishing the raw rice samples:

T1: The milled rice from raw rice 14% moisture content of the untreated with ozonation.

T2: The milled rice from raw rice 14% moisture content treated ozonized at a concentration of 30 mg/L for 5 hours.

T3: The milled rice from raw rice 18% moisture content of untreated with ozonation.

T4: The milled rice from raw rice 18% moisture content treated ozonized during 5 hours at a concentration of 30 mg/L.

The treatments (T1 and T3) were then subjected to ozone gas at a concentration of 30 mg/L for 3 hours (the milled rice from untreated with ozonation raw rice).

T5: The milled rice with a 14% moisture content that was ozonized for 3 hours at a concentration of 30 mg/L.

T6: The milled rice 18% moisture content treated ozonized at a concentration of 30 mg/L for 3 hours.

The ozone treatment time for raw and milled rice was calculated based on the elimination of most microorganisms to prolong the storage time.

Determination amylose content (Ac)

The amylose content was estimated as stated in AACC 61-03.01 (2022). By dissolving a standard concentration of amylose mg/ml according to the manufacturer's instructions, a standard concentration of amylose mg/mL was prepared. Using a volumetric flask with a capacity of 100 mL, 40 mg of pure potato amylose (Sigma Co.) was weighed. The mixture was then heated in a boiling water bath for 15 minutes with 1 mL of 95 percent ethanol and 9 mL of 1 N sodium hydroxide. The solution was then allowed to cool to the ambient temperature before being filled up with distilled water. Then, a series of standard solutions were prepared by adding

(1, 2, 3, 4, and 5) mL of the solution, followed by (0.2, 0.4, 0.6, 0.8, and 1.0) mL of acetic acid 1 N, and 2 mL of 0.2 percent iodine solution to five volumetric flasks of 100 mL, supplied with the distilled water, shaken thoroughly, covered with aluminum foil, and left for 20 minutes before reading with a spectrophotometer at 620 nm. In a 100 mL volumetric flask, the same technique was followed for samples, however, instead of the pure potato amylose, 100 mg of rice flour was used, and 1 mL of 95 percent ethanol was added before adding 9 mL of 1 N sodium hydroxide and thoroughly the mixture was shaken. The solution was then cooked for 15 minutes in a water bath, cooled to the ambient temperature and topped up with distilled water. In a 100 mL volumetric flask, 5 mL of sample solution was combined with 1 mL 1N of acetic acid and 2 mL and 0.2 percent of iodine solution was added to the solution, which was then filled with distilled water. Then after, everything is up to you. The prepared solutions were kept in a dark box for 20 minutes before being used, and then the absorbance was measured [2].

Amylopectin content determination (Ap)

The following equation was used to compute the amount of amylopectin in the sample.
Amylopectin = (100 -Amylose %)

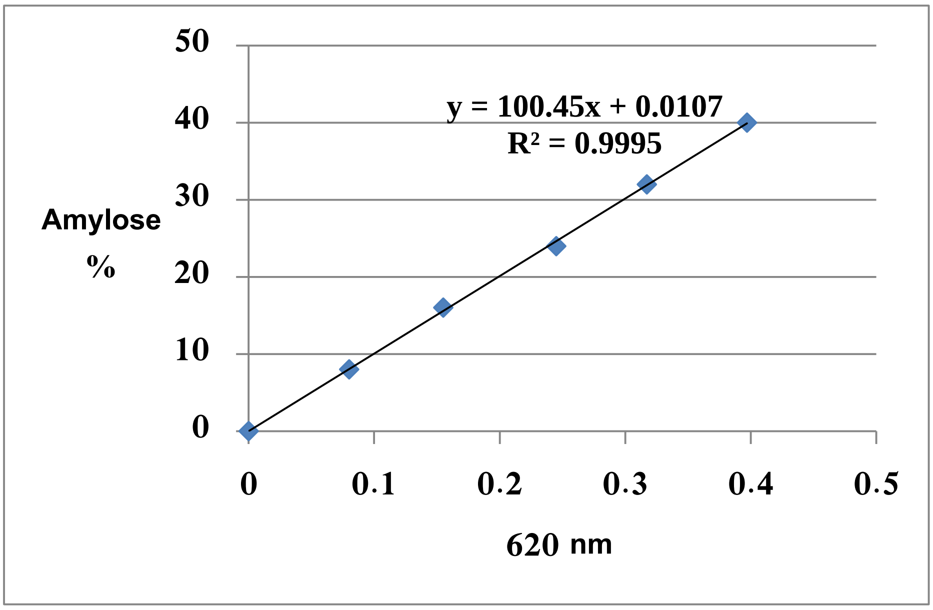

FIGURE 2 The amylose solution standard curve

TABLE 1 The readings from the spectrophotometer for the standard solution of the standard curve

Concentration	Readings
0	0.000
8	0.080
16	0.155
24	0.245
32	0.317
40	0.397

Sample storage

The milled rice and milled rice flour samples was packed in 1.5 liter glass bottles fitted with a metal screw cap as stated under the storage conditions at the ambient temperature. The storage was lasted for 180 days.

Data analysis

SAS stands for statistical analysis system (2012). The statistical program was used in data analysis to investigate the effect of various treatments on the studied traits using a complete random design (CRD), The Least Significant Difference (LSD) test was used to compare the significant differences between the means.

Results and discussion

Table 2 shows the levels of amylose and amylopectin in the milled rice samples before and after 180 days of storage.

TABLE 2 Amylose and amylopectin values for all treatments before and after storage

Treatments	Before Storage		After Storage	
	Amylose %	Amylopectin %	Amylose %	Amylopectin %
T1	18.93	81.07	18.42	81.58
T2	19.03	80.97	18.75	81.25
T5	19.33	80.67	18.90	81.10
T3	18.33	81.67	17.85	82.15
T4	18.73	81.27	18.15	81.85
T6	18.93	81.07	18.35	81.65
LSD values	1.44 NS	3.218 NS	1.06 NS	2.95 NS

Values are the average of three replicates. NS: No significant differences at level ($P \leq 0.05$)*.

Percentages of amylose and amylopectin values for white rice and for all treatments before and after storage indicated that the values of amylose before storage was (18.93, 19.03, 19.33, 18.33, 18.73, and 18.93) % for the treatments (T1, T2, T5, T3, T4, and T6), respectively. We noticed a rise in the amylose content between treatments T1 and T2, treatments T1 and T5, between treatments T3 and T4, and treatments T3 and T6 due to ozone treatment. There was no statistical significant difference at the level ($P \leq 0.05$)*. The ozone treated rice contained 16.26% amylose, so when cooking it had a high level of stickiness and more viscosity [7]. The amylose decreased from 15.27% to 12.64% owing to the oxidation and radical processes that occur with ozonation breakdown of starch molecules as a result of prolonged exposure to ozone [17]. The amylose content of jasmine rice samples ranged between (10.67-17.54)% (based on dry weight), which classified samples of low amylose rice [18].

Amylopectin values before storage was (81.07, 80.97, 80.67, 81.67, 81.27, and 81.07)% for treatments (T1, T2, T5, T3, T4, and T6), respectively. We noticed a decrease in amylopectin content between treatments T1 and T2, treatments T1 and T5, between treatments T3 and T4, and treatments T3 and T6 due to the ozone treatment with no significant differences at the level ($P \leq 0.05$)*. Amylose and amylopectin are the main component of starch which impact on its physical properties such as gelatinization, retraction, viscosity, and elasticity [14,19].

The values of amylose after storage were (18.42, 18.75, 18.90, 17.85, 18.15, and 18.35)% for the treatments (T1, T2, T5, T3, T4, and T6), respectively. We noticed an increase in amylose content between treatments T1 and T2, treatments T1 and T5, between treatments T3 and T4, and treatments T3 and T6 due to the ozone treatment with no significant differences at the level ($P \leq 0.05$)*. Amylolytic enzymes are still active during rice storage; however their activities decline over time and the interior regions of the endosperm has a higher temperature, which is suitable for enzymatic activity (amylase) and the other hydrolytic enzymes, therefore the amylose concentration reduces during storage. Amylose is more susceptible to enzyme attack, whereas amylopectin is more resistant [2].

Amylopectin values after storage were (81.58, 81.25, 81.10, 82.15, 81.85, and 81.65)% for treatments (T1, T2, T5, T3, T4, and T6), respectively. We noticed a decrease in amylopectin content between treatments T1 and T2, treatments T1 and T5, between treatments T3 and T4, and treatments T3 and T6 due to the ozone treatment with no statistical significant differences at the level ($P \leq 0.05$)*. The positive response of the carboxyl and carbonyl groups to ozone causes a change in starch molecules' viscosity and rheological qualities including low viscosity even at large concentrations and favorable binding properties, the ability to form and cohesion. Thus, its application has risen in the food processing sector. The effect of ozone on both physical and chemical properties is primarily rebound and binding. Ozone changes crystallization, viscosity, the expansion rate, and gelatinization temperatures due to the interchange of AC and AC molecules and enzymatic alterations, as well [10].

Conclusion

At both moisture content of ozone treatment of the raw rice and milled rice, there was no significant influence at the level (P0.05)*, on the amount of amylose and amylopectin.

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