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Original Research Article

Effect of Drying Temperature on the Sensory Characteristics and Antioxidant Activities of *Momordica charantia* Slices

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Abstract: *Momordica charantia* slices were dried with air at different temperature, and the effects of drying temperature on the sensory characteristics and antioxidant activities were investigated. The results were as followed. *Momordica charantia* slices showed some shrinkage and their color gradually turned brown from pale green with temperature increase from 30 to 120℃. The total flavonoids content and reducing power of prepared *Momordica charantia* slices first decreased and then increased, and iron ion chelating activity first increased and then decreased with temperature increase. And The DPPH scavenging ability was higher at 60 and 120℃. The content of total flavonoids of *Momordica charantia* slices was significantly correlated with the reducing power and had relatively strong correlation with DPPH free radical scavenging activity.
Keywords: *Momordica charantia*, Drying temperature, Sensory characteristics, Antioxidant activity.

INTRODUCTION

Momordica charantia, alias Jin litchi, bitter gourd, is annual herbaceous climbing plant, belonged to cucurbitaceous. It originated in tropical and subtropical regions, and is now widely distributed in tropical, subtropical and temperate regions [1]. *Momordica charantia* has higher nutritional and healthy value. Research suggests that it contains many biological active ingredients, such as alkaloids, triterpenes, flavonoids, polysaccharides, saponins and so on. And it has the effects of hypoglycemic action, anti-cancer, anti-virus, enhancing immunity, etc. With the gradual deepening of recognition to nutritional composition and medicinal value, *Momordica charantia* gained favor from many domestic and foreign consumers. Research related with *Momordica charantia* has become one of research focuses among many scholars [2-4]. Usually, the shelf life of *Momordica charantia* is very short owing to its seasonal production and tender texture tissue. Processing *Momordica charantia* into dried slice has important practical significance for adjusting the market demand to ensure the perennial supply [5].

At present, the research on *Momordica charantia* mostly concentrated in healthy aspect such as hypoglycemic effect, and the antioxidant capacities are few. In this paper, the effects of different hot air drying temperature on the sensory properties and antioxidant activities of *Momordica charantia* were investigated. This research might provide a reference for the better development of *Momordica charantia* nutritional value.

MATERIALS AND METHODS

Materials and Reagents

Momordica charantia was purchased from New Milky Way supermarket of Linfen city. Alcohol, methanol, sodium hydroxide, rutin, sodium nitrite and aluminum muriate (analytical grade) were purchased from Kermel Chemical Reagent Co., Ltd. (Tianjin, China). Diphenyl-picryl hydrazide, sodium dihydrogen phosphate, disodium hydrogen phosphate, trichloroacetic acid, potassium ferricyanide, ferricchloride, ferrozine and ferrous sulfate (analytical grade) were purchased from National Pharmaceutical Group Chemical Reagent Co., Ltd.

Instruments

GZX-9246 MBE Digital blast drying box, Shanghai Boxun Industrial Co., Ltd. medical equipment factory, Shanghai, China; RJ-TDL-40C Centrifuge, Ruijiang Analysis Instrument Co., Ltd., Wuxi, China; UV-1100 spectrophotometer, Shanghai Meipuda Instrument Co., Ltd., Shanghai, China; MJ-25BM04B Mill, Guangdong Midea premium appliances manufacturing Co., Ltd., Guangzhou, China. SHA-C Water-bathing Constant Temperature Vibrator, Ronghua Instrument Manufacture CO., LTD, Jintan, China.

Processing of *Momordica charantia* slices

Fresh *Momordica charantia* with thick flesh, no shrinkage, no defect and disease was selected. It was washed with clean tap in order to remove the dust, sediment and pesticide residues in the surface of

Momordica charantia. The inner seeds of *Momordica charantia* were discarded and the *Momordica charantia* was cut into 0.5 cm slices. Afterward, the slices were dried in air blast drying box under different temperatures. They were not dried until the water content of slices was below 4%. The prepared *Momordica charantia* slices were placed into drying container for next experiment.

Preparation of sample extracts

The prepared *Momordica charantia* slices were smashed power and sieved with 80 meshes. 1 gram of *Momordica charantia* power was placed into an Erlenmeyer flask, and 10mL of 70% ethanol was added into the flask. Then, the flask containing the suspension of *Momordica charantia* power and ethanol was shaken with SHA-C Water-bathing Constant Temperature Vibrator for 1 h at 45℃. Afterward, the suspension was filtered and sample extract was collected for next analysis.

Determination of total flavonoids

Total flavonoids content was measured according to a colorimetric assay [6]. A 1-mL aliquot of standard solution of rutin at different concentrations (0, 10, 20, 30, 40, and 50 mg L^{-1}) or appropriately diluted sample extract was added to 10-mL volumetric flasks containing 4 mL water. At the onset of the experiment, 0.4 mL of 5% $NaNO_2$ was added to the flask. After 6 min, 0.4 mL of 10% $AlCl_3$ was added. At 6 min, 4 mL of 4% NaOH was added to the mixture. Immediately, the solution was diluted to a final volume of 10 mL with water and mixed thoroughly. The absorbance of the mixture was determined at 510 nm versus the prepared blanks. Total flavonoids content was expressed as mg rutin equivalents per gram drying *Momordica charantia* slices.

Determination of antioxidant activities

1. Determination of DPPH free radical scavenging activity

1.0mL of appropriately diluted sample extract was added to 4.0 mL of DPPH (120μmol·L^{-1}) in methanol, shaken well and placed for 75 min. Its absorbance value A_1 at 517 nm was determined. In addition, the absorbance A_2 of sample extracts without DPPH and the value A_0 of the mixture of 4.0 mL of DPPH in methanol with 1.0ml of distilled water at 517 nm were also measured [7]. The scavenging rate of DPPH radicals was calculated as scavenging rate (%) = [1-(A1- A_2)/ A_0] ×100%.

2. Determination of reducing power

A 0.5 mL aliquot of appropriately diluted sample extract was mixed with 2.5 mL of phosphate buffer (0.2 M, pH 6.6) and 2.5 mL of 1% potassium ferricyanide in 20 mL test tubes. The mixtures were incubated for 20 min in water bath of 50 ℃. After cooling, 1 ml of 10% trichloroacetic acid was added to the mixtures, followed by centrifugation. The upper layer (2.5 mL) was mixed with 2.5 mL of distilled water and 1 mL of 0.1% ferricchloride. The reaction lasted for 10 min. Afterward, the absorbance was measured at 700nm [8].

3. Determination of Fe^{2+} chelating activity

1.0 mL of appropriately diluted sample extract was mixed with 2.0 mL of 0.2% $FeSO_4$. After 30 min of incubation at 37℃, 0.5 ml of 0.3% ferrozine was added and reacted for 10 min at 37℃. The absorbance of the Fe^{2+}-ferrozine complex was measured at 510 nm. The chelating activity of the sample extract for Fe^{2+} was calculated as chelating rate (%) = [1-(A_1- A_2)/ A_0]×100%, where A_0 was the absorbance of the control (blank, without sample extract), A_1 was the absorbance of sample extract in the presence of ferrozine and A_2 was the absorbance of sample extract without ferrozine [9].

STATISTICAL ANALYSIS

The data were processed by analysis of variance using DPS7.05 statistical software (Refine Information Tech. Co., Ltd., Hangzhou, China).

RESULTS AND ANALYSIS

Time requirement of *Momordica charantia* slice

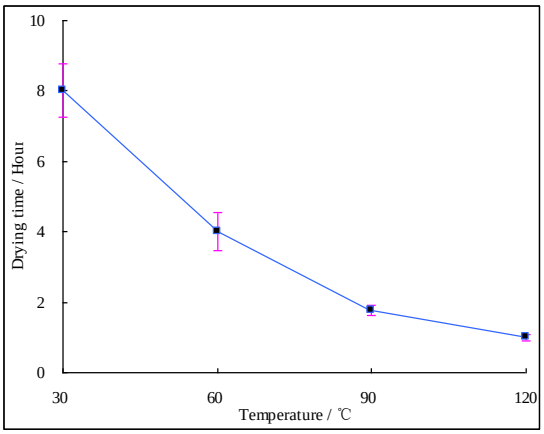

Fig. 1: Time requirement of *Momordica charantia* slice with different drying conditions

As shown in Figure 1, with the increase of drying temperature, the required time to dry *Momordica charantia* slice quickly reduced. At 30 ℃, it took 8 hours to dry *Momordica charantia* slice, while the drying time greatly shortened at 120 ℃, which was approximately 1/8 compared to that of 30℃.

Effect of drying temperature on the sensory characteristics of *Momordica charantia*

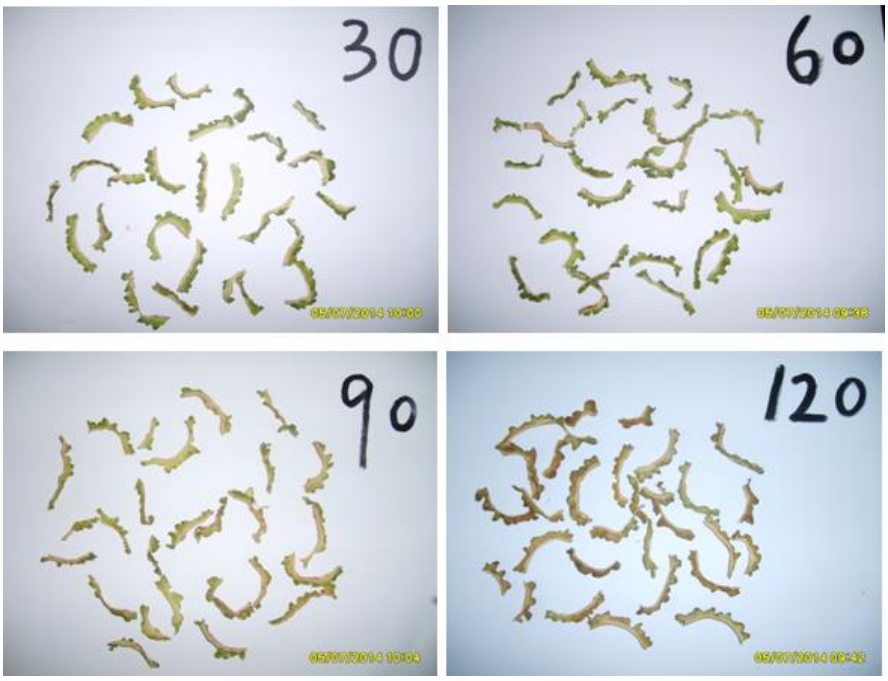

Fig. 2: photos of *Momordica charantia* slices under different drying temperature

As described in Figure 2, with drying temperature increase from 30 to 120 ℃, the color of dried *Momordica charantia* slices gradually turned brown from pale green. As for shrinkage, *Momordica charantia* slices showed less shrinkage at 30 or 60 ℃, larger shrinkage at 90℃, and most serious shrinkage at 120℃. When *Momordica charantia* slices were brewed with deionized water, the tea brewed with dried *Momordica charantia* slices at 30, 60 or 90 ℃ demonstrated characteristic smell and no burned taste, but the tea at 120 ℃ showed slight burned taste.

Effect of drying temperature on the total flavonoids content of *Momordica charantia* slices

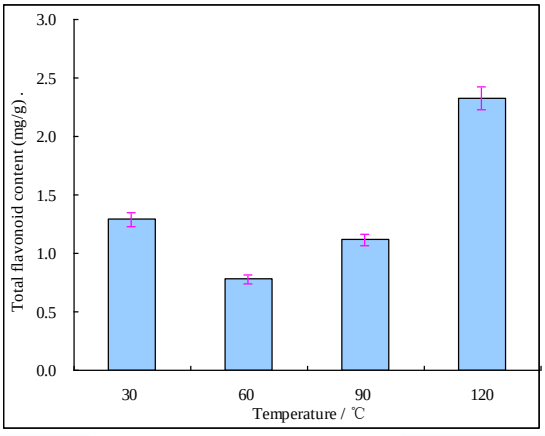

Fig. 3: Total flavonoids content of *Momordica charantia* slices under different temperature treatment

As shown in Figure 3, the total flavonoids content of *Momordica charantia* slices firstly decreased and then increased with drying temperature enhancement. *Momordica charantia* slices showed the lowest total flavonoids content of 0.78 mg/g at 60 ℃. And it showed the highest total flavonoids content at 120℃, which was approximate 2 times higher than that of 60℃. The reason was probably as followed. Compared to 90 or 120℃, drying *Momordica charantia* slices needed longer time at 60℃. Moreover, 60℃ was higher

temperature than 30℃. And, the time to dry *Momordica charantia* slices at 90℃ or 120℃ was shorter, so more flavonoids might be retained. Though drying *Momordica charantia* slices needed the longest time at 30℃, low temperature led to the relatively small loss of flavonoids.

Effects of drying temperature on antioxidant activities of *Momordica charantia* slices

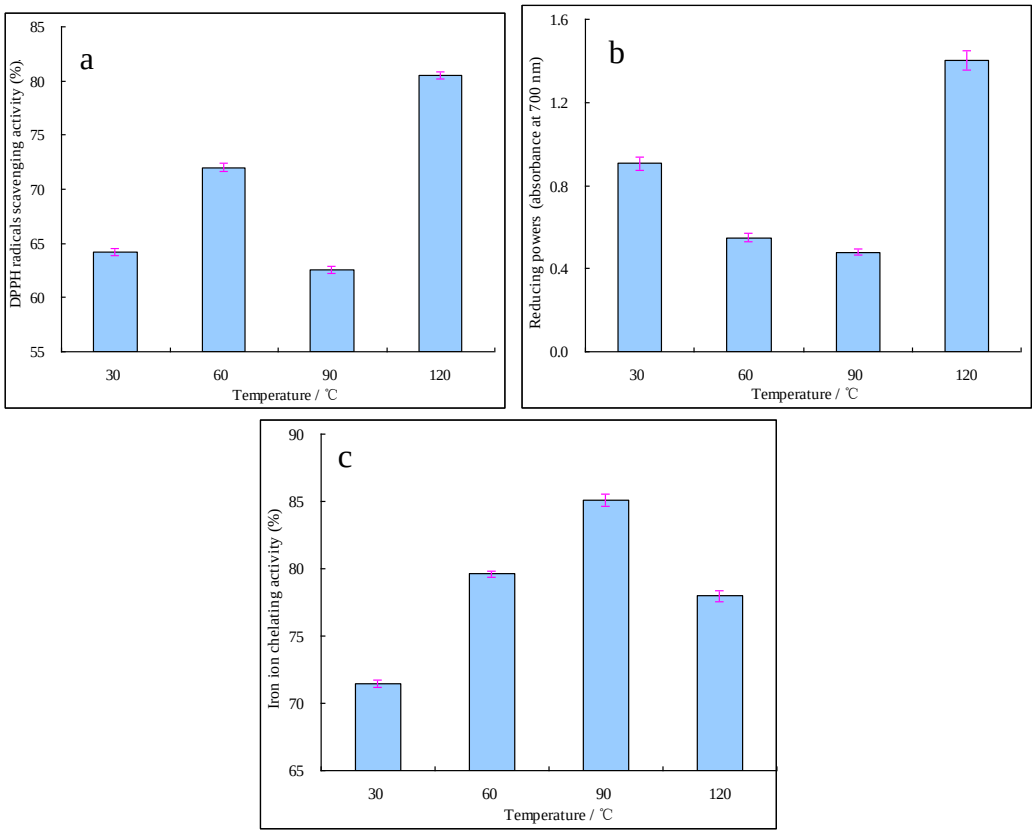

Fig. 4: Effects of drying temperature on DPPH radicals scavenging activity (a), reducing power (b) and iron ion chelating activity (c) of *Momordica charantia* slices

DPPH free radical scavenging activity represents the ability to provide hydrogen atoms [10]. As shown in Figure 4a, *Momordica charantia* slices demonstrated the highest DPPH free radical scavenging capacity at 120 ℃. They showed the lowest DPPH free radical scavenging capacity at 90℃, which was 22.3% lower than that of 90 ℃. At 60 ℃ *Momordica charantia* slices exhibited higher DPPH free radical scavenging capacity that was 15.1% higher than that of 90 ℃. Reducing power characterized the ability to provide electron [11]. Figure 4b suggested the reducing power of *Momordica charantia* slices decreased with temperature increase from 30 to 90 ℃, and the reducing power of *Momordica charantia* slices at 90 ℃ was 47.1% lower than that of 30℃. However, at 120℃, the reducing power of *Momordica charantia* slices at 120 ℃ increased rapidly compared with that of other temperatures, which was 55%, 156% and 192.9% higher than that of 30, 60 and 90℃, respectively. As described in Figure 4c, the iron ion chelating activity of *Momordica charantia* slices firstly increased and then decreased with temperature increase from 30 to 90 ℃. And it reached to the maximum value at 90 ℃, which was 19.1% higher than that of 30℃.

Correlation analysis of total flavonoids content and antioxidant activities

Table 1: Correlation coefficient of total flavonoids content and antioxidant activities of *Momordica charantia* slices

Correlation coefficient	Total flavonoid content
DPPH radicals scavenging activity	0.68
Reducing power	0.94*
Iron ion chelating activity	-0.2

* $p<0.05$

As shown in Table 1, the content of total flavonoids of *Momordica charantia* slices was significantly correlated with the reducing power, had relatively strong correlation with DPPH free radical scavenging activity between them, and had little correlation with iron ion chelating activity. Above results suggested that total flavonoids probably played a leading role in reducing power, and also served as important function in DPPH free radical scavenging activity [12]. During drying process, since *Momordica charantia* slices was subject heat for long time, Maillard reaction occurred. Maillard reaction might provide more substance rich in carbonyl, so *Momordica charantia* slices exhibited the strongest iron ion chelating activity at 90 ℃ [13, 14]. In terms of 60 ℃ with lower temperature and longer time, or 120 ℃ with the highest temperature and the shortest time, *Momordica charantia* slices also showed higher iron ion chelating activity at 60 or 120℃.

CONCLUSION

When *Momordica charantia* slices were dried with air at different temperature, they showed some shrinkage and their color gradually turned brown from pale green with temperature increase from 30 to 120℃. The total flavonoids content and reducing power of prepared *Momordica charantia* slices first decreased and then increased, and iron ion chelating activity first increased and then decreased with temperature increase. And The DPPH scavenging ability was higher at 60 and 120℃. The content of total flavonoids of *Momordica charantia* slices was significantly correlated with the reducing power and had relatively strong correlation with DPPH free radical scavenging activity.

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