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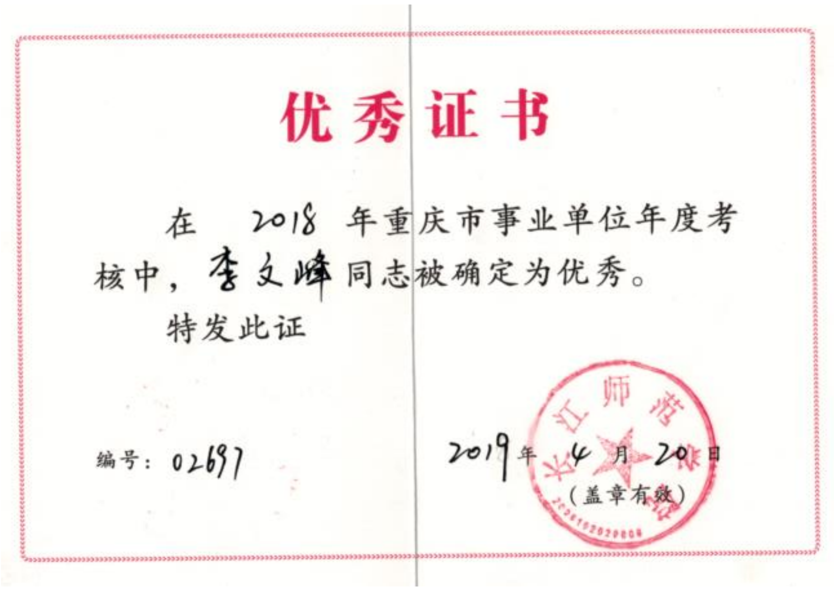
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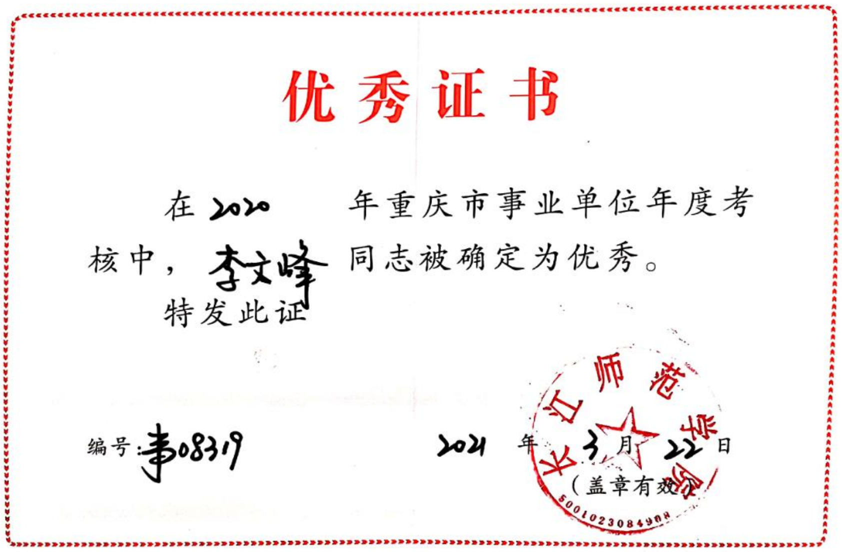
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9. Journal of Food Science, 2018, 83, 552-558.
10. International Journal of Food Sciences and Nutrition, 2019, 70(3), 311-322.
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Pectin Alleviates High Fat (Lard) Diet-Induced Nonalcoholic Fatty Liver Disease in Mice: Possible Role of Short-Chain Fatty Acids and Gut Microbiota Regulated by Pectin

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Supporting Information

ABSTRACT: Consumption of pectin contributes to changes in the gut microbiota and the metabolism of short-chain fatty acids (SCFAs). We aimed to investigate the effects of and mechanism by which pectin prevented nonalcoholic fatty liver disease (NAFLD) in mice that were fed a high-fat diet containing 30% lard (HF). HF-fed mice that orally ingested pectin for 8 weeks exhibited improvements in lipid metabolism and decreased oxidative stress and inflammation through a mechanism regulated by the mitogen-activated protein kinase pathway. Pectin dose-dependently generated an increase in acetic acid (from 566.4 ± 26.6 to 694.6 ± 35.9 μmol/mL, $p < 0.05$) and propionic acid (from 474.1 ± 84.3 to 887.0 ± 184.7 μmol/mL, $p < 0.05$) contents and significantly increased the relative abundance of *Bacteroides* (from 0.27% to 11.6%), *Parabacteroides* (from 3.9‰ to 5.3%), *Olsenella* (from 2.9‰ to 1.3%), and *Bifidobacterium* (from 0.03% to 1.9%) in the gut of HF-fed mice. Intestinal microbiota and SCFAs may thus contribute to the well-established link between pectin consumption and NAFLD.

KEYWORDS: *pectin, nonalcoholic fatty liver disease, gut microbiota, short-chain fatty acid, MAPK pathway*

INTRODUCTION

Pork has long been consumed by individuals throughout the world for its protein and fat. In China, the abdominal fat plate, visceral fat, and fatty meat of porcine carcasses are decocted to acquire lard, which is applied to daily meals by many families. Lard is characterized by a high level of saturated fatty acids (SFAs), a relatively low level of essential *n*-6 fatty acids (approximately 9−10%), and a low level of essential *n*-3 fatty acids (<1%).[1] Notably, diets containing SFAs are strongly correlated with the development of nonalcoholic fatty liver disease (NAFLD).[2] NAFLD is strongly correlated with obesity, dyslipidemia, hypertension, oxidative stress, and liver injury, conditions that threaten human health.[3,4]

The consumption of dietary fibers was recently shown to contribute to alleviating the risk of NAFLD.[5] Pectin is one of the most important soluble dietary fibers in human nutrition and is present at high concentrations in citrus peels, apples, and other fruits.[6,7] Citrus pectin reduces the serum total triglyceride (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) levels in mice fed a high-cholesterol diet.[6] Pectin has also shown the capacity to improve lead acetate-, tetrachloromethane-, sodium nitrite-, and polychlorinated biphenyl-induced impairments in glutathione reductase (T-SOD) and glutathione peroxidase (GSH-Px) activities in the liver.[8] Although pectin is a dietary fiber that potentially attenuates NAFLD, limited information about its mechanisms is available.

Pectin is fermented by the resident microbiota in the cecum and colon to produce short chain fatty acids (SCFAs).[9] According to Zhao and colleagues, SCFAs with 2−5 carbons (acetate, propionate, butyrate, and valerate) have the potential to reduce plasma TC levels, nonhigh-density lipoprotein cholesterol (non-HDL-C) levels, and the non-HDL-C/HDL-C ratio.[10] Propionate may also contribute to reductions in hepatic lipogenesis by inhibiting acetyl-coenzyme A carboxylase (ACC) and fatty acid synthase (FAS).[11] Importantly, SCFAs are signaling molecules that can activate the mitogen-activated protein kinases (MAPKs) extracellular-signal-regulated kinase (ERK) and, to a lesser extent, c-Jun N-terminal kinase (JNK) and p38/MAPK.[12] Additionally, SCFAs limit the secretion of proinflammatory cytokines and inhibit the activation of the transcription factor NF-κB, thereby suppressing the development of liver damage.[12] Pectin and its fermentation production (SCFAs) are hypothesized to be putative tools to regulate fatty acid metabolism and subsequent oxidative stress and liver damage.

In this study, we utilized a 16sRNA gene-based approach, targeted fatty acid profiling technology and conventional biochemical analyses to comprehensively investigate the anti-NAFLD effects of pectin and the interrelations among the gut microbiota, fatty acid metabolism, oxidative stress, and liver injury. We attempted to understand the mechanism underlying the anti-NAFLD effects of pectin, which is crucial for obtaining useful information that will improve our understanding of the health benefits of dietary pectin.

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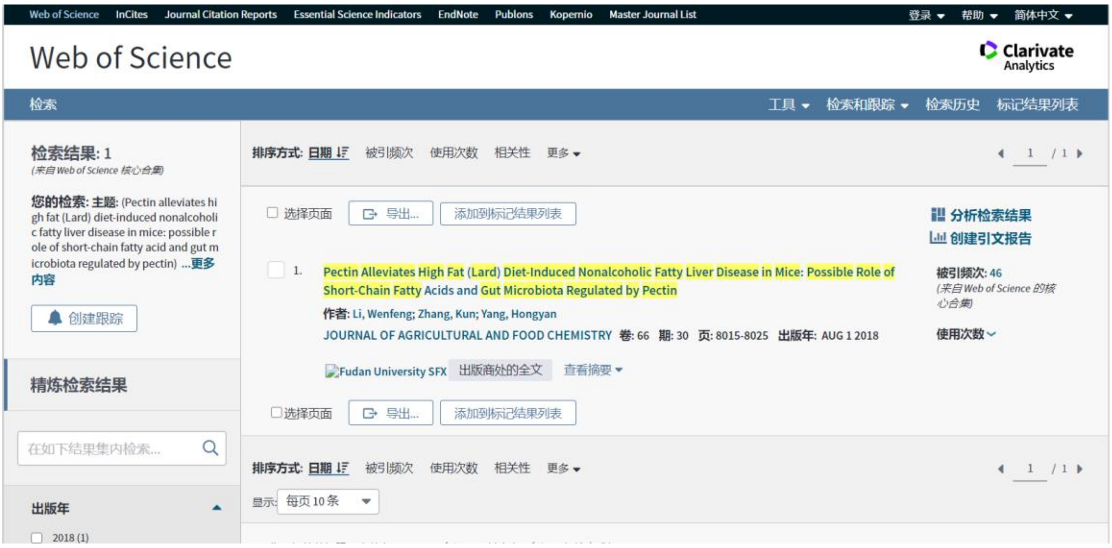
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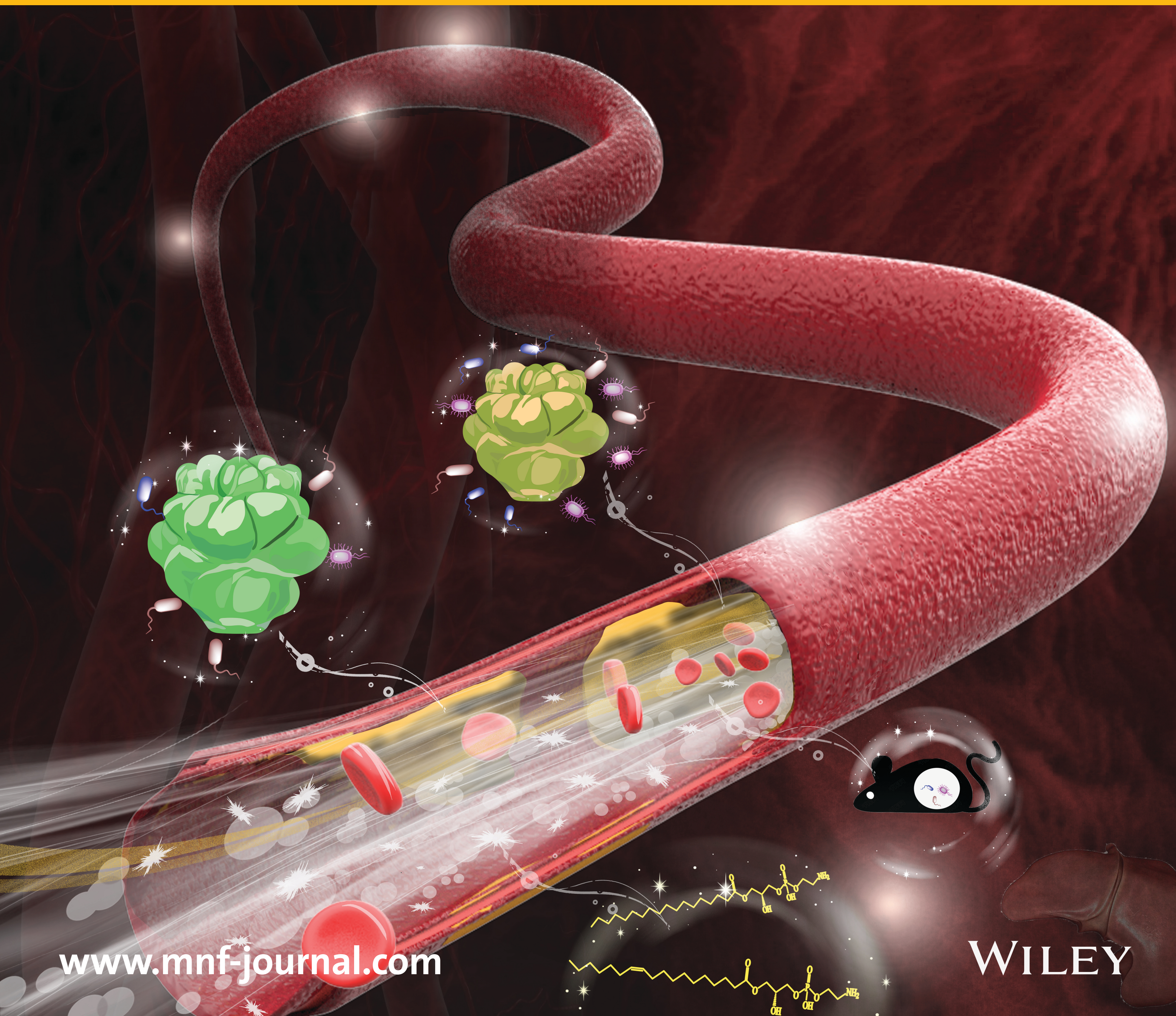

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Salted and Unsalted Zhàcài (*Brassica juncea* var. *tumida*) Alleviated High-Fat Diet-Induced Dyslipidemia by Regulating Gut Microbiota: A Multiomics Study

Wenfeng Li, Chunlian Chen, Mengting Chen, Xiangyang Zhang, Qin Ji, Yu Wang, Qiaoran Zheng, Si Tan, Xiaoxv Gao, and Yalong Lu**

Scope: Zhàcài (ZC), a salting-processed *Brassica juncea* var. *tumida* vegetable, is widely consumed as a pickle, but little is known about the health benefits of both salted and unsalted ZC as a whole food.
Methods and Results: The preventive effects of salted and unsalted ZC against dyslipidemia are assessed in high-fat (HF) diet-fed mice. HF intake for 12 continuous weeks cause dyslipidemia in mice, as evidenced by the elevations in serum total triglyceride, total cholesterol, and low-density lipoprotein cholesterol levels by 30%, 66%, and 117%, respectively. Metabolomics analysis and the 16S rRNA genes sequencing suggest that dietary administration of salted and unsalted ZC (2.5% w/w) alleviates HF-induced dyslipidemia, metabolic disorders of short-chain fatty acids, and disturbance of intestinal flora in mice. These positive effects of unsalted ZC are stronger than those of salted ZC. Moreover, fecal bacteria transplantation confirms the antidyslipidemia of ZC.
Conclusion: These results suggest that consumption of ZC may prevent HF-induced dyslipidemia by regulating gut microbiota.

1. Introduction

Dyslipidemia, defined as an unusual content and species of lipids in the blood, is commonly characterized by high levels of total triglyceride (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C) and low levels of high-density lipoprotein cholesterol (HDL-C).[1] Dyslipidemia is closely related to the risk of cardiovascular disease, which is a major cause of morbidity and even leads to mortality.[2] Increasing evidence suggests that the long-term intake of a high-fat (HF) and/or high-carbohydrate diet can induce dyslipidemia together with disorder of gut microbiota.[3–5] Interestingly, a high consumption of vegetables can improve HF diet-induced dyslipidemia, disordered intestinal flora, and epithelial barrier integrity.[6,7] It should be noted that salted vegetables might not reduce the cancer risk like fresh vegetables do.[8,9] Thus, whether salted vegetables can alleviate dyslipidemia like fresh vegetables is unclear.

Long-term salting fermentation not only endows vegetables with a new flavor but also changes the nutritional contents, including sugars, fatty acids, and glucoraphanin, which might imply changes in the health benefits.[10–12] Generally, salted vegetables are considered detrimental to cardiovascular health because an excessive intake of salt can cause health problems, including hypertension, cardiovascular disease, and others.[13] However, the salted radish also presents a health effect in reducing the blood pressure of rats, which might be because it still contains polyphenols, arginine, α-linolenic acid, and other unknown antihypertension substances.[10] Moreover, *Lactobacillus fermentum* CQPC05 in salted Sichuan pickles can decrease serum TC and TG in high-fat diet-fed mice.[14] Accordingly, it is difficult to conclude the nutritive value of salted vegetables by an element that has negative or positive effects on health. Some studies have shown that whole foods might cause a stronger combined influence because bioactive components may work together synergistically.[15] Thus, the antidyslipidemia benefit of whole salted vegetables and the correlative differences with unsalted vegetables need to be clarified.

Zhàcài (ZC) is a traditional Chinese pickle, and it is produced from the swollen stem of tumorous stem mustard (**Figure 1**A), which possesses noteworthy antioxidant activity and antitumor activity.[16] Generally, the fresh swollen stem of tumorous stem mustard is also broadly called ZC. In the current industrial production of ZC, salting is an important processing step. Therefore, ZC might contain a high level of salt. In fact, ZC was desalted before consumption to decrease the negative influence of salt on health. Accordingly, ZC can be used as an ideal material to investigate the effects of salting processing on intrinsic

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Molecular Nutrition & Food Research

长江师范学院李文峰团队在TOP期刊Molecular Nutrition & Food Research发表题为Salted and unsalted Zhàcài (*Brassica juncea* var. *tumida*) alleviated high-fat diet-induced dyslipidemia by regulating gut microbiota: A multiomics study的封面论文。该论文第一及通讯作者为长江师范学院李文峰博士。

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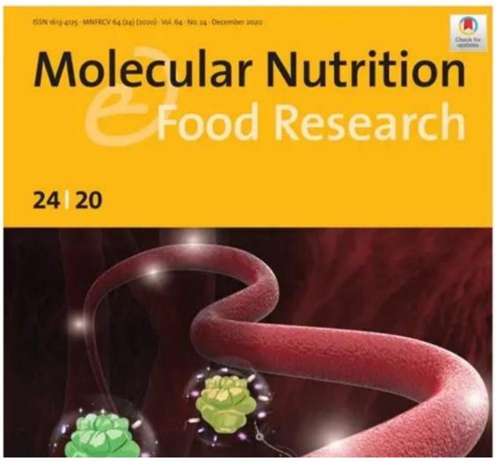

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Polyphenol-Rich Loquat Fruit Extract Prevents Fructose-Induced Nonalcoholic Fatty Liver Disease by Modulating Glycometabolism, Lipometabolism, Oxidative Stress, Inflammation, Intestinal Barrier, and Gut Microbiota in Mice

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Supporting Information

ABSTRACT: Fructose as a daily sweetener is widely recognized as a risk catalyst for nonalcoholic fatty liver disease (NAFLD). The aim of current study is to evaluate the effects and molecular mechanism by which polyphenol-rich loquat fruit extract (LFP) prevents NAFLD in mice fed 30% fructose water (HF) for 8 weeks. Administration of LFP to HF-fed mice mitigated abnormal body weight, disordered lipid metabolism, oxidative stress, and inflammation through a mechanism regulated by the AKT, ChREBP/SREBP-1c, Nrf2, and TLR4/MyD88/TRIF pathways. LFP caused a significant decrease in the endotoxin content (16.67−12.7 EU/mL) in the liver of HF-fed mice. LFP not only improved HF-induced breakage of the intestinal barrier via interacting with tight junction proteins (ZO-1, occludin), mucin, and immunoreaction in the colon but also maintained normal colonic *Firmicutes*/*Bacteroidetes* ratios and the relative abundance of *Veillonella* in HF-fed mice. Our results suggest that LFP may serve as a nutritional agent for protecting liver in HF-fed mice.

KEYWORDS: *loquat fruit, polyphenol, fructose, nonalcoholic fatty liver disease, gut microbiota*

INTRODUCTION

Dietary fructose, a monosaccharide, is commonly added to foods as a sweetener, both in personal consumption and in the food industry.[1] It is noteworthy that global changes in dietary habits have caused the distinct elevation of fructose consumption over the past 200 years, specifically, the wide application of high-fructose corn syrup (HFCS), which comprises 55−90% fructose.[1,2] Generally, production of HFCS requires the following four manufacturing steps: (1) extracting starch from corn by wet milling; (2) saccharification and liquefaction to hydrolyze polymer starch to monomer dextrose; (3) isomerization to convert dextrose to fructose; (4) fractionation to enrich the concentration of fructose in the isomerization product stream.[3] Epidemiological investigations have indicated a strong link between the intake of a high-fructose diet (HF) and nonalcoholic fatty liver disease (NAFLD), hepatic de novo lipogenesis, obesity, type II diabetes, and cardiovascular disease.[4−6]

NAFLD is defined as steatosis affecting >5% of hepatocytes in the absence of excessive significant alcohol consumption, other liver disease, or the consumption of steatogenic drugs.[7] Previous studies have documented that the genesis of HF-induced NAFLD is associated with the disorder of lipid metabolism, imbalance of the oxidant/antioxidant system, and inflammation in the liver.[8,9] These risk factors are caused by the primary metabolites and byproducts of fructose, including glucose, lactate, free fatty acid, very low-density lipoprotein (VLDL), triglyceride, uric acid, and methylglyoxal, metabolizing in the liver and extrahepatically.[10] Recently, increasing evidence has also suggested that HF-induced NAFLD is linked to microecological disturbance in the intestine that damages the gut barrier and increases endotoxin production.[11,12] Today, 15% of the total calories in the modern adolescent diet is composed of refined sugar (including fructose), while 10% of the population derives at least 25% of their total calories from refined sugar.[6] Therefore, an effective strategy to prevent liver injury due to HF dietary ingestion is urgently required. Interestingly, polyphenol-rich extracts from fruits or vegetables have shown extraordinary abilities to protect against chronic liver injury.[13]

Loquat fruit (*Eriobotrya japonica* (Thunb.) Lindl.) is a delicious fruit native to the southeast of China.[14,15] In China, loquat fruit is not only consumed as food but is also a traditional Chinese medicinal material with anti-inflammation, antioxidant (against DPPH· and ABTS$^+$, etc. *in vitro*), anticancer, antihyperlipidemia, antidiabetic, and gastro-protection activities.[16,17] These health benefits of loquat fruit might be attributed to its polyphenol compounds[18,19] including phenolic acids, flavonoids, lignans, stilbenes, and tannins.[20,21] Polyphenols with strong antihyperlipidemia, antihyperglycemia and

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Glycosides changed the stability and antioxidant activity of pelargonidin

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ABSTRACT

Pelargonidin glucosides represent important pigments in the food industry. We compared the pH, metal-ionic, and thermal stability of pelargonidin (Pg), pelargonidin-3-*O*-glucoside (P3G), pelargonidin-3-*O*-rutinoside (P3R), and pelargonidin-3,5-*O*-diglucoside (P35DG) using visible spectrum analysis at 400–700 nm. The results showed that the pH stability of P3G and P3R exceeded Pg and P35DG. Ferrous ion (Fe^{2+}) enhanced the stability of P3G and P3R, while thermal processing-induced degradation was evident in Pg and pelargonidin glycosides, according to the 1.5-order kinetic equation. Moreover, Pg and P35DG displayed higher temperature sensitivity than P3G and P3R. Then, 2,2-diphenyl-1-picrylhydrazyl (DPPH)-scavenging activity and ferric reducing antioxidant power (FRAP) analysis of the chemical models, and cell activity and reactive oxygen species assays of Caco2 and human umbilical vein endothelial cells (HUVECs) were used to identify the relationship between the pelargonidin structure and antioxidant activity. The DPPH-scavenging activity and FRAP values increased when the number and molecular weight of the pelargonidin glycosides were reduced, increasing the pro-oxidant properties in the Caco2 cells and the antioxidant activity in the HUVECs. Accordingly, this study suggested that glycosides might enhance the stability while decreasing the antioxidant activity of pelargonidin since glycosides increase the steric hindrance during reactions.

1. Introduction

Consumer demand for natural food coloring has grown rapidly in recent years, with continuing annual market growth of 10–15% expected (Cortez, Luna-Vital, Margulis, & Mejia, 2017). Anthocyanins are the largest group of water-soluble pigments responsible for the vivid red, purple and blue colors in many fruits, vegetables and flowers (Jing et al., 2012). More than 500 anthocyanins with different molecular structures have been identified thus far in fruits and vegetables. These are mainly based on cyanidin, delphinidin, pelargonidin, peonidin, petunidin and malvidin (Andersen, 2008). Among these pigments, pelargonidin glycosides, an anthocyanin commercially extracted from radish cultivars, is used most widely in the food industry (Park et al., 2016), however it is not stable and degrades easily into colorless or brown-colored compounds (Li et al., 2020).

Results of a previous study suggested that anthocyanin stability is not merely a function of the final processing temperature but is, in addition, influenced by the molecular structure and intrinsic properties of the product as well as by processes such as pH, storage temperature, oxygen, and the presence of metallic ions (Patras, Brunton, O'Donnell, & Tiwari, 2010). Of these influencing factors, the molecular structure of anthocyanins was found to be the most pivotal, due to the fact that it is innate and ineffaceable. In the anthocyanin aglycone, for example, the ring B substituents and the presence of additional hydroxyl or methoxyl groups (Fig. 1A) were found to decrease stability when in neutral media (Castañeda-Ovando, Pacheco-Hernández,). Accordingly, Fleschhut, Kratzer, Rechkemmer, and Kulling (2006) suggested that pelargonidin is the most stable of the anthocyanidins. Thus, pelargonidin might be used more wildly in food processing than cyanidin, in spite of that is the most mainly anthocyanidin in nature food (Park et al., 2016). However, natural pelargonidin is generally linked to one or various sugars in red radish (Li et al., 2020; Park et al., 2016), which influence the stability of pelargonidin glycosides (Garzón & Wrolstad, 2001), while varying water activity is strongly associated with their molecular structure (Garzón et al., 2001). Brauch, Kroner, Schweiggert, and Carle (2015) found that glycosylation enhanced the stability of

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Degradation kinetics of pelargonidin-3-(*p*-coumaroyl)diglucoside-5-(malonyl)glucoside and pelargonidin-3-(feruloyl)diglucoside-5-(malonyl) glucoside in red radish during air-impingement jet drying

Wenfeng Li[a,*], Xinxin Pang[a], Jinfeng Xiao[a], Xinyu Wang[a], Ruiyan He[a], Xin Zhao[b]

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Antioxidant activity

ABSTRACT

Red radishes were dried using air-impingement jet drying (AIJD) at different temperatures of 50 °C, 60 °C, and 70 °C. The color displayed a significant change, while the total anthocyanin content (TAC), and DPPH· and ABTS$^{\cdot+}$ scavenging activities were dramatically decreased in AIJD-dried red radishes compared to fresh red radishes. Using UHPLC-QqQ-MS/MS analysis, eight pelargonidin glucosides and two cyanidin glucosides were identified in red radishes. The pelargonidin-3-(*p*-coumaroyl)diglucoside-5-(malonyl)glucoside (P3PD) and pelargonidin-3-(feruloyl)diglucoside-5-(malonyl)glucoside (P3FD) signified the two primary anthocyanins in red radishes. AIJD caused the degradation of P3PD and P3FD while following the second-order kinetic equation. The degradation rate and half-life ($t_{1/2}$) of the P3PD degradation increased with the elevation of the AIJD temperature, while that of P3FD decreased. The enthalpy of activation presented values between 2.87 kJ/mol and 3.04 kJ/mol for P3FD, and between 37.07 kJ/mol and 37.23 kJ/mol for P3PD. The positive ΔG suggested that the degradation of P3PD and P3FD was a non-spontaneous reaction. The transition state displayed lower structural freedom than the P3PD and P3FD, as evidenced by the negative ΔS. These results could contribute to inhibiting the degradation of anthocyanins in red radishes during processing.

1. Introduction

Radish (*Raphanus sativus* L.) is an important brassicaceous vegetable in Asian countries, especially China, Japan, and Korea (Park et al., 2011). Radishes are typically classified by color, size, cultivation requirements, and other features (Hara, Ito, Asai, & Kuboi, 2009). Among radishes, red radishes exhibit an attractive red color due to the presence of high anthocyanin levels (Park et al., 2016). Therefore, red radishes are also an important source of natural colorants, which are mainly used in the food and cosmetics industry. Furthermore, it is widely known that anthocyanins present substantial health benefits, including free radical scavenging abilities and antioxidant activity, as well as anti-cancer, anti-diabetes, anti-inflammation, antiatherogenic, and cardio-protective properties (Mazza & Kay, 2008). However, the water content in fresh red radishes exceeds 90%, which makes it an ideal environment for microbial breeding and, therefore, vulnerable to perishing (Li et al., 2020). Consequently, in China, these vegetables are commonly dehydrated for effective preservation, and to decrease the moisture content, endowing them with a specific mouthfeel, taste, and flavor.

Drying is one of the most important and most common methods applied in the food industry to reduce the moisture content in food products and enhance preservation (Singh, Orsat, & Raghavan, 2012). Recently, air-impingement jet drying (AIJD) as an efficient drying technology has been successfully used in onion (Li, Wang, Xiao, Zhang, & Yang, 2015), kiwifruit (Huang, Li, Shao, Gao, & Yang, 2017; Li, Yuan, Xiao, & Yang, 2016), purple potato (Qiu, Wang, Song, Deng, & Zhao, 2018) and others. Compared to hot air drying, AIJD facilitates a faster dehydration rate, higher polyphenol content, stronger antioxidant activity, and less browning in the dried fruit and vegetables (Huang et al., 2017; Li et al., 2015). However, AIJD is not used during the drying procedure of red radishes. During the AIJD process, the water content of samples is rapidly decreased with an increase in temperature in the center of the sample (Li et al., 2016), which is conducive to the degradation of anthocyanins due to its thermal instability as a flavonoid in food (Patras, Brunton, O'Donnell, & Tiwari, 2010). Moreover, the deterioration of anthocyanins in food can also be attributed to processing factors, such as oxygen, ozone, light, pH, ultrasound, irradiation, elevated pressure, and using the pulsed electric field technique (Tiwari,

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ORIGINAL PAPER

New Insights into the Mechanisms of Polyphenol from Plum Fruit Inducing Apoptosis in Human Lung Cancer A549 Cells Via PI3K/AKT/FOXO1 Pathway

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Abstract
Recent studies have been found that polyphenols from plums fruits can inhibit the proliferation of multiple cancer cells, while the molecular mechanism was unclear. This study aimed to investigate the molecular mechanism underlying the pro-apoptotic effect of purified plum polyphenols (PPP) on human lung cancer A549 cells. Quercitrin (quercetin-3-*O*-glucoside, 814.19 ± 40.71 mg/g) was identified as the primary polyphenol in PPP via ultra high-performance liquid chromatography coupled with triple quadrupole mass spectrometry (UHPLC-QqQ-MS/MS). PPP showed a strong capacity for inhibiting the proliferation of the A549 cells by inducing apoptosis, which was reflected by an increase in the Bax/Bcl-2 ratio. Additionally, the inhibitory rate of PPP on the A549 cells were higher than that of vitamin C when the treatment dose exceeded 160 μg/mL. Transcriptome analysis suggested that PPP-induced apoptosis was closely associated with regulating the phosphatidylinositol 3-kinase (PI3K)/protein kinase B (AKT)/forkhead box protein O 1 (FOXO1) pathway in the A549 cells. Subsequently, as an activator of AKT, SC79 was applied to confirm that the inhibition of AKT phosphorylation play an important role in the PPP-induced apoptosis of the A549 cells. These results illustrated the potential of PPP as a dietary compound for the prevention of cancer or for use during chemotherapy.

Keywords Antiproliferative activity · Lung cancer · Polyphenol · *Prunus salicina* Lindl · Transcriptome

Introduction

Plums, which refer to the fruits of the genus *Prunus*, denote a readily available and widely consumed food resource, while also representing a lucrative horticultural crop [1]. Plums play an important role among the many so-called "functional foods," the effect of which on human health has been recognized for a long time [2]. Recent research on the health benefits of plums continue to show promising results regarding its anticancer, anti-inflammatory, antioxidant, anti-hyperlipidemia, and other health-promoting properties [3]. Furthermore, it is well-known that the polyphenols in plums can inhibit the proliferation of breast cancer cells, human hepatocellular carcinoma, gastric cancer cells, human cervical carcinoma cells, and leukemia cells [2, 4]. These anti-proliferation properties of plums are associated with phytochemicals, especially polyphenol compounds [2–4], which primarily include quercitrin, chlorogenic acid, rutin, epicatechin (EC), and others [1, 5]. However, the molecular mechanism by which the polyphenols in plums inhibit the proliferation of cancer cells remains poorly understood.

Polyphenols isolated from fruits and vegetables possess the potential to interfere with the initiation, development, and progression of cancer by modulating various cell signaling pathways to induce apoptosis and cell cycle arrest [6]. On the one hand, the activation of mitogen-activated protein kinase (MEK)-extracellular regulated kinase (ERK) plays an important role in the apoptosis of lung carcinoma A549 cells [7, 8]. On the other hand, polyphenol induces apoptosis via caspase activation, the regulation of B cell lymphoma-2 (Bcl-2), and the inhibition of the phospholipid kinase, phosphatidylinositol 3-kinase (PI3K)/

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Capsaicin alleviates lipid metabolism disorder in high beef fat-fed mice

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ABSTRACT

This study was designed to evaluate the preventive mechanisms of capsaicin on beef fat-induced lipid metabolism disorder, oxidative stress and dysbacteriosis in mice. Mice were fed a control diet or a 30% beef-fat diet (BF) with or without 0.001% capsaicin for 12 weeks. The consumption of a BF with capsaicin effectively inhibited obesity and dyslipidemia in mice. Consumption of capsaicin improved the oxidative stress by reducing the hepatic malonaldehyde content and elevating the glutathionperoxidase activity. GC–MS analysis showed that the acetic acid content in the cecum was significantly increased by capsaicin supplementation. The enteric microflora species was not changed significantly by the consumption of capsaicin in BF-fed mice. The alleviation of dyslipidemia might be because capsaicin enhanced the antioxidant activity and elevated the enteric acetic acid levels in high beef fat-fed mice. Our results suggest that the ingestion of capsaicin might be an effective strategy for preventing beef fat-induced hyperlipidemia.

1. Introduction

Chongqing hot pot is a popular dish that is consumed by many people around China, and the two major raw materials are beef fat and chili peppers (Tang et al., 2014). The beef fat endows the hot pot with a special aroma and flavor, and the fat is obtained by decocting the abdominal fat plate, visceral fat and fatty meat from cattle. Currently, Chongqing hot pot and other dishes rich in beef fat make up a considerable proportion of the commercial meals for the people of Chongqing. A previous study suggested that beef fat from the different parts of cattle carcasses contains saturated fatty acids at high levels (33.45–42.71%) (Moon et al., 2018). It should be noted that a high level of saturated fat consumption promotes insulin resistance, impaired glucose tolerance, systemic inflammation, abdominal obesity and, most notably, dyslipidemia; in addition, saturated fat consumption has also been linked to cardiovascular disease (Poudyal & Brown, 2015), which is the leading cause of death worldwide (Tortosa-Caparrós, Navas-Carrillo, Marín, & Orenes-Piñero, 2017). Dyslipidemia is an affirmative risk factor for cardiovascular disease, and it is characterized by elevated concentrations of serum triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and unusual amounts of accumulated fat (Li et al., 2018). Our previous research indicated that the long-term ingestion of diets rich in saturated fatty acids can induce intense oxidative stress by increasing the malonaldehyde (MDA) levels and inhibiting the glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD) activities (Li, Zhang, & Yang, 2018). In addition, the consumption of a high saturated fatty acid diet also induces the dysbiosis of gut microbiota (Arias-Jayo et al., 2018). It is well known that oxidative stress and the maladjustment of the gut microbiota are correlated with disorders of lipid metabolism (Li et al., 2018). Therefore, it is necessary to develop an effective strategy to prevent beef fat-induced disorders of lipid metabolism.

Chili peppers add flavor and spice to food and possess a potential medicinal value (Luo, Peng, & Li, 2011). The spicy flavor of the chili pepper is caused by capsaicinoids, which are the main bioactive compounds in chili peppers (Zhang et al., 2013a). Capsaicin is the primary capsaicinoid in chili peppers, followed by dihydrocapsaicin, nordihydrocapsaicin, homodihydrocapsaicin, and homocapsaicin (Zhang et al., 2013b). Capsaicin has attracted great attention due to its extensive pharmacological properties, such as its analgesia activities and the anticancer, anti-inflammation, antioxidant, anti-obesity and hypocholesterolemic properties (Luo et al., 2011; Zhang et al., 2013c). Increasing evidence has revealed that capsaicin regulates the amount of food intake and suggests that this function correlates with the restoration of synaptic connections within the nucleus of the solitary tract as well as NR-1 immunoreactivity within the nodose ganglia (Gallaher, Johnston, & Czaja, 2014; Gallaher, Larios, Ryu, Sprunger, & Czaja, 2010; Gallaher, Ryu, Larios, Sprunger, & Czaja, 2011; Ryu, Gallaher, &

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Multivariate Analysis Illuminates the Effects of Vacuum Drying on the Extractable and Nonextractable Polyphenols Profile of Loquat Fruit

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New Horizons in Food Research

Abstract: The current study evaluated the effects of vacuum drying on the whole polyphenol profile of loquat fruit, including extractive and nonextractive polyphenols. Absorbance analysis determined that total polyphenol content and antioxidant levels were higher in loquat fruit vacuum dried at 140 °C than in loquat fruit vacuum dried at 70 °C. The results of ultra-HPLC–triple quadruple mass spectrum analysis showed that 15 phenolic acids and 17 flavonoids were found in dried loquat fruit. Multivariate integrative (MINT) sparse partial least square-discriminant analysis showed that vacuum drying affects the polyphenol profile of loquat fruit. Co-analysis of principal component analysis, partial least square-discriminant analysis, and orthometric partial least square-discriminant analysis revealed that vacuum drying mainly changed the content of chlorogenic acid, cryptochlorogenic acid, protocatechuic acid, phloretin, and hesperidin in loquat fruit. Chlorogenic acid (12.020 to 39.153 μg/g d.b. [dried base weight]), the main polyphenol in dried loquat fruit, was degraded to caffeic acid (0.028 to 2.365 μg/g d.b.) and protocatechuic acid (0.014 to 18.285 μg/g d.b.) during vacuum drying. Moreover, vacuum drying also induced the isomerization of chlorogenic acid into cryptochlorogenic acid (1.628 to 12.737 μg/g d.b.). These results might be used to develop dried loquat fruit with high levels of polyphenols and antioxidant activity.

Keywords: loquat fruit, multivariate analysis, nonextractable polyphenols, polyphenols, vacuum-drying

Practical Application: Interests in polyphenols of loquat fruit had increased greatly because of their possible role in health benefits. This work provided a holistic insight in the effects of vacuum drying on polyphenols profile of loquat fruit. Current results have contributed to the development of vacuum-drying method, which produced loquat fruit rich in polyphenols. Furthermore, it also suggested that multivariate analysis was a feasible method to reveal the important changes of polyphenols profile during food processing.

Introduction

Loquat (*Eriobotrya japonica* L.) is a subtropical evergreen fruit tree that is native to the southeast of China (Elsafy, 2014). In recent years, loquat fruit has received considerable attention due to its anticough, antiasthma, anti-inflammation, antidiabetic, anticancer, gastroprotective, and antioxidant activities (Hong, Lin, Jiang, & Ashraf, 2008), which are closely associated with polyphenolic compounds, phenolic acids, and flavonoids (Hong et al., 2008). However, the fresh loquat fruit is a perishable plant food as it contains a large proportion of water, leading to great economic losses (Elsafy, 2014; Zhou, Li, Sun, Xu, & Chen, 2011). Furthermore, loquat fruit harvest season is brief in the early summer and therefore the fresh fruit is not acquired throughout the year (Saberian, Amooi, & Hamidi-Esfahani, 2014). Thus, conservation treatments to preserve the polyphenols in loquat fruit are necessary (Elsafy, 2014). Drying is one of the oldest techniques for food preservation, and it is widely used to decrease moisture content and the water activity of foods to minimize microorganisms, enzymatic reactions, and other biochemical reactions (Jin, Mujumdar, Zhang, & Shi, 2018). Currently, hot air drying, solar drying, halogen oven drying, refractance window drying, flat-plate solar collector drying, microwave drying, vacuum freeze drying, and vacuum drying have been applied in loquat drying studies (Elsafy, 2014; Zhou, Li, Sun et al., 2011). However, hot air drying (60 to 90 °C) causes the total polyphenol and total flavonoid content to decrease to 300 and 120 mg/100 g d.b. (dried base weight) from 370 and 210 mg/100 g d.b. of fresh loquat fruit, respectively (Elsafy, 2014). Zheng, Xia, and Lu (2015) found that hot air drying, microwave drying, and vacuum drying led to a decrease in total polyphenol content of loquat flower by 64%, 35%, and 13%, respectively. It should be noted that the total polyphenols of loquat fruit and flower were extracted by an ethanol or methanol method, and polyphenol content was analyzed by the Folin–Ciocalteu colorimetric method in these studies (Elsafy, 2014; Zhou, Li, Sun et al., 2011). Regrettably, there was no report on the polyphenol profiles that remained in dried loquat fruit, defining the health benefits related to their consumption.

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Hepatoprotective Effects of Sophoricoside against Fructose-Induced Liver Injury *via* Regulating Lipid Metabolism, Oxidation, and Inflammation in Mice

Wenfeng Li and Yalong Lu

Abstract: The dried fruit of *Sophora japonica* L. is a traditional Chinese herb tea rich in sophoricoside that is an isoflavone glycoside. The aim of current study was to investigate the hepatic protective effect of sophoricoside in high fructose (HF) diet fed mice. Healthy male mice were fed 30% fructose water and treated 80 and 160 mg/kg·bw sophoricoside continuously for 8 wk. Our data showed that administration of sophoricoside at 80 and 160 mg/kg·bw observably decreased the body weight and liver weight in HF-fed mice. It was found that the treatment of sophoricoside decreased the hepatic cholesterol and triglyceride levels, and serum low-density lipoprotein-cholesterol and apolipoprotein-B levels, and elevated the serum high-density lipoprotein-cholesterol and apolipoprotein-A1 levels. Moreover, the administration of sophoricoside decreased the HF-caused elevations of hepatic malonaldehyde, interleukin-1 and tumor necrosis factor-α levels, while increased the HF-induced decreases of hepatic superoxide dismutase and glutathione peroxidase activities. Meanwhile, serum aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase activities were reduced by treatment of sophoricoside in HF-fed mice. Histopathology of hematoxylin and eosin (H&E) and oil red O staining of liver tissues also confirmed the beneficial effects of sophoricoside against liver injury induced by HF-diet in mice. These findings indicated that sophoricoside may be a novel natural isoflavone for alleviating HF-induced liver injury.

Keywords: Sophoricoside, high fructose diet, hyperlipidemia, liver injury, antioxidant

Practical Application: Fruit of *Sophora japonica* L. is a traditional herb tea and it recently becomes popular in China. Sophoricoside is an isoflavone glycoside (Genistein-4'-*O*-β-D-glucopyranoside) isolated from *S. japonical* L, and it possessed differential effects on the body health. The ingestion of sophoricoside or sophora fruit tea may be a novel strategy to prevent non-alcoholic fatty liver disease.

Introduction

Fructose has been a part of human diet for thousands of years, and it is found in highest concentrations in high fructose corn syrup (55% to 90% fructose), honey (40% fructose), and fruits (up to 7.6% fructose) (Raatz, Johnson, & Picklo, 2015; Sun & Empie, 2012). In the last decades, high fructose corn syrup as an inexpensive sweetener is widely used in food processing industry, and this causes a grave increase (30%) in consumption of fructose (Pereira et al., 2017; Tappy & Lê, 2010). With the increase of fructose consumption, nonalcoholic fatty liver disease (NAFLD) in world has increased to unintelligible levels (Nomura & Yamanouchi, 2012; Suwannaphet, Meeprom, Yibchokanun, & Adisakwattana, 2010). It is well known that NAFLD start with simple steatosis, and it can proceed to more serious conditions, nonalcoholic steatohepatitis, liver cirrhosis and hepatocellular carcinoma that threating life severely (Fan & Cao, 2013; Nomura & Yamanouchi, 2012). The high fructose diet (HF)-induced NAFLD is strongly associated with de novo lipogenesis, lipotoxicity, oxidative stress, and inflammation (Rolo, Teodoro, & Palmeira, 2012; Tappy & Lê, 2010). Therefore, promising pharmacological agents and food nutrients needs to be emerged to prevent HF-induced liver injury.

Recently, plant foods play a major role in the prevention of liver injury induced by a high fructose diet because of them including a vast number of flavonoids (Suwannaphet et al., 2010). Flavonoids are secondary metabolites with low molecular weight in plant, and it can be classified as flavones, isoflavones, flavonols, flavanones, flavanols, flavanonols, and anthocyanidins (Balasundram, Sundram, & Samman, 2006). The dried fruit of *Sophora japonica* L., which belongs to the traditional Chinese herb tea, is rich in isoflavones, flavanones, triterpenoids, and other phytochemicals beneficial to health (He et al., 2016). Among the isoflavones of *S. japonica* L., genistein and genistin (Genistein-7-*O*-β-D-glucopyranoside) have been used for prevention of hyperlipidemia and liver injury (Kojima, Uesugi, Toda, Miura, & Yagasaki, 2002; Mohamed Salih, Nallasamy, Muniyandi, Periyasami, & Carani Venkatraman, 2009). Additionally, sophoricoside is also an isoflavone glycoside (Genistein-4'-*O*-β-D-glucopyranoside) isolated from *S. japonical* L. and its molecular structure is represented in Figure 1. Many studies have confirmed that sophoricoside has the beneficial effects, including anti-obesity, anti-oxidation, anti-inflammation, hemostatic properties, anticancer, and regulating of lipogenesis (Wu et al., 2013). Evidences suggest that sophoricoside may

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IN VITRO AND ANIMAL STUDIES

Fructooligosaccharide enhanced absorption and anti-dyslipidemia capacity of tea flavonoids in high sucrose-fed mice

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ABSTRACT
The ingestion of tea flavonoids (TF) and fructooligosaccharide (FOS) contributes to anti-hyperlipidaemia. In the current study, TF or FOS or TF together with FOS were orally administrated to mice fed a high sucrose (HS) diet. UPLC-MS analyses showed that FOS significantly increased the concentrations of urine catechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate and gallocatechin gallate. The mice fed with HS for continuous 8 weeks exhibited severe dyslipidemia and abnormal liver fat accumulation. However, oral administration of FOS or TF or in combination significantly decreased the effects of HS on the serum total cholesterol, total triglycerides, low-density lipoprotein and high-density lipoprotein. Co-treatment of FOS and TF more effectively regulated lipid metabolism by inhibiting lipogenesis. Intake of TF together with FOS reduced the level of dyslipidemia marker (elaidic acid) by increasing anti-oxidative activity than treatments of FOS or TP alone in HS-fed mice. Histological observations of liver confirmed these health benefits.

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Absorption; dyslipidemia; fructooligosaccharide; sucrose; tea flavonoids

Introduction

Sucrose has been an important part of the human diet for many thousands of years, and its consumption has markedly increased all over the world over the past two decades (Chicco et al. 2016). Sucrose is a disaccharide that consists of a fructose monomer and a glucose connected by glycosidic linkages (Oliveira et al. 2014). Ours and many other studies have suggested that diets rich in fructose exert a high risk of dyslipidemia, oxidative stress, obesity, insulin resistance, inflammation, and hepatic impairment in humans and experimental animals (Li et al. 2016a, 2016b; Zhao et al. 2016). Similarly, previous studies have indicated that a high glucose diet can induce an increase in body weight, triglycerides, cholesterol, and fatty acid synthase (Oliveira et al. 2014; Schultz et al. 2015). These findings imply that long-term consumption of sucrose may have adverse effects on health. In fact, there are a number of studies that have demonstrated that ingestion of a diet rich in sucrose results in dyslipidemia (Schultz et al. 2015; Softic et al. 2017). Thus, valid preventive strategy of sucrose-induced dyslipidemia needs to be exploited urgently.

Fructooligosaccharide (FOS), a non-digestible saccharide, has presented a protective effect against hyperlipidaemia, hypercholesterolaemia and abnormal fat accumulation (Phuwamongkolwiwat et al. 2014a). Furthermore, it has been reported that the body weights and their plasma triglyceride, cholesterol and low-density lipoprotein cholesterol (LDL-C) have been significantly reduced by feedings of Oolong, black, and green tea leaves to the animals (Khan and Mukhtar 2007). These health effects of tea (*Camellia sinensis*) are closely associated with catechins, which primarily consist of catechin (C), epicatechin (EC), epigallocatechin (EGC), epicatechin gallate (ECG), and epigallocatechin gallate (EGCG), with EGCG the most abundant catechin in tea with the strongest physiological activities (Feng 2006; Li et al. 2016c). However, previous studies have indicated that the absorption of tea flavonoids (TF) *in vivo* is extremely poor based on oral administration (39% for EC, 6–31% for ECG, 8–14% for EGCG) and intragastric administration

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Chemometric analysis reveals influences of hot air drying on the degradation of polyphenols in red radish

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Abstract: Hot air drying is a commonly used technology in the preservation of red radish. This study was designed to investigate the correlations among total polyphenol content, total flavonoid content, antioxidant activities and polyphenol compounds in hot air dried red radish via chemometric analysis. UHPLC-QqQ-MS/MS analysis detected nine non-anthocyanin polyphenols and one anthocyanin in fresh and dried red radish samples, and found that hot air drying at 80 °C caused an increase in the *p*-coumaric acid and ferulic acid content of the red radish. The integral effect of hot air drying on the polyphenol profile of red radish was analyzed by principle component analysis, while sparse partial least squares-discriminant analysis showed that hot air drying induced changes mainly in the contents of poncirin, naringenin, phloetin and cyanidin-3-glucoside. These polyphenol degradations occurred as non-spontaneous and endothermic reactions during the hot air drying process, following first-order reaction kinetics.

Keywords: degradation dynamics; mixOmics; principal component analysis; *Raphanus sativus*; thermodynamic analysis.

1 Introduction

Red radish (*Raphanus sativus*) is a biennial vegetable crop that has been produced as specialty produce in the Chongqing Fuling district of China for more than a century [1, 2]. Fresh red radish is rich in polyphenols, especially anthocyanins [2], which exhibit a wide range of physiological properties, including anti-glycation, anti-oxidant, anti-cancer, anti-allergenic, anti-atherogenic, anti-inflammatory, and anti-microbial benefits, as well as cardioprotective and vasodilatory effects [3, 4]. Significantly, however, the moisture content of fresh red radish is higher than 90%, which makes it an ideal environment for microbial breeding and, therefore, vulnerable to perishing. Generally, red radish is consumed in China as either a fresh, pickled or dehydrated vegetable, the latter of which is beneficial as it not only reduces the moisture content for long-term preservation but also endows the vegetable with a distinctive mouthfeel and flavor [5].

Drying is a widely used method for the industrial preservation of numerous fruits and vegetables, in which the moisture content and water activity is decreased to minimize microorganisms, enzymatic reactions and other biochemical reactions [6]. Hot air drying extends the shelf life of these products and can also provide powders to be used as additives in other food matrixes [7]. Further advantages include faster processing and the opportunity to control the quality of samples, however, hot air drying does result in the loss of biologically active compounds [8, 9]. In mulberries, for example, hot air drying has been found to induce the degradation of anthocyanins, including cyanidin 3-O-glucoside and cyanidin 3-O-rutinoside [10]. Patras et al. suggested that the degradation of anthocyanins due to thermal processing, such as hot air drying, is caused primarily by the cleavage of covalent bonds or enhanced oxidation reactions [11]. While much research has focused on the degradation of anthocyanins [10, 12], little is known about the equally significant but more complex effects of hot air drying on non-anthocyanin polyphenols in fruit and vegetables, such as oxidant dissociation, depolymerization and biomacromolecule separation effects [13]. Consequently, this study aims to ascertain the changes that occur in the anthocyanin and other polyphenol compounds of red radish during hot air drying.

There are 15 polyphenols found in the various radish cultivars, including anthocyanins and phenolic acids

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FULL ARTICLE

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Effect of hot air drying on the polyphenol profile of Hongjv (*Citrus reticulata* Blanco, CV. Hongjv) peel: A multivariate analysis

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Abstract

Hongjv peel (HP), a spice rich in polyphenols, is generally dried for its preservation. Hot air drying (HAD) at 50°C, 60°C, 70°C, and 80°C was performed in this study to dehydrate HP and it was found that the drying rate increased in line with the increase of HAD temperature. Absorbance analysis showed that HAD induced significant decreases in the total polyphenol content (TPC), total flavonoid content (TFC), and antioxidant activity of HP. Ultra performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) analysis found 18 phytochemicals in the HP, including 11 flavonoids, 6 phenolic acids, and 1 triterpenoid, while multivariate analysis revealed that chlorogenic acid, hesperidin, naringenin, and phloretin in the HP were influenced mainly by HAD. HAD-induced degradations were non-spontaneous, endothermic reactions, consistent with the first-order reaction kinetics. In addition, the results suggest that HAD is more likely to degrade polyphenols that include an ester bond or glucoside.

Practical applications

Among the various methods of preservation used to process spices, HAD is still the most effective. The polyphenol of HP possesses numerous health benefits, including being anti-oxidative, anti-inflammatory, anticancer, antiproliferative, and other qualities. This study provides a method through which to obtain insight into the effects of HAD on polyphenols in food, and indicates potential targets to increase the polyphenol content in HP.

KEYWORDS
citrus, degradation, hot air drying, multivariate analysis, polyphenol

1 | INTRODUCTION

Citrus is among the world's most important fruit crops, with average annual production of approximately 116 million tons (Marey & Shoughy, 2016). Hongjv (*Citrus reticulata* Blanco, CV. Hongjv) is a characteristic citrus variety grown in the Wanzhou district, Chongqing, China (Chen, Huang, et al., 2011). Currently, the main products derived from Hongjv are fresh fruit, juice, candied tangerine fruit, and dried citrus peel, the latter of which is not only used as a spice, but also as a traditional Chinese medicine (Li & Ren, 2017). It is well known that citrus peel is rich in polyphenols, carotenoids, essential oils, pectin, and water-insoluble dietary fiber (Kammoun Bejar, Ghanem, Mihoubi, Kechaou, & Boudhrioua Mihoubi, 2011; Ramful, Bahorunb, Bourdonc, Tarnusc, & Aruoma, 2010). In particular, the characteristic polyphenol compounds in citrus include mainly naringin, hesperidin, narirutin, and neohesperidin (Khan, Abert-Vian, Fabiano-Tixier, Dangles, & Chemat, 2010), which

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Citric acid-enhanced dissolution of polyphenols during soaking of different teas

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Abstract

This study examined the dissolution kinetics and antioxidant activity of tea polyphenols during the soaking of white, yellow, green, oolong, black, and dark teas. All these teas were, respectively, soaked with either freshly boiled distilled water (DW) or 10 mmol/L citric acid–water solution. The residue obtained from one extraction was used for the next extraction and this process was performed consecutively 10 times, soaking for 30 s each time. UHPLC-QqQ-MS measurement identified epigallocatechin gallate as the major polyphenol in white, yellow, green, oolong, and black tea infusions. As soaking times increased, the polyphenol concentrations rose initially and then dropped. Antioxidant activity was noted to decrease as soaking times increased in all tea infusions except for the DW-soaked oolong and dark teas. These findings suggested that citric acid could increase the polyphenol content in tea infusions. Specifically, the cumulative contents of epigallocatechin gallate was noted to increase 2.1–5.1 times.

Practical applications

After water, tea is one of the most consumed beverages in the world. Drinking tea has been linked to the reduced risk of various diseases, including cancer, cardiovascular system disease, obesity, and neurodegenerative diseases, largely due to its rich polyphenol content. Moreover, the addition of citrus to a tea infusion provides an interesting and feasible method for increasing the dissolution of tea polyphenols, a finding that offers extensive potential for applications in the development of compound tea drinks.

KEYWORDS

antioxidant activity, citric acid, dissolution kinetics, polyphenols, soaking, tea

1 | INTRODUCTION

Tea, which is made from the leaves of *Camellia sinensis*, is one of the most consumed beverages in the world, after water (Dai et al., 2017; Li et al., 2018). Traditionally, teas have been typically classified according to their associated processing methods, from which varying characteristics and degrees of fermentation (oxidation) are produced (Ning et al., 2016). Generally, teas are classified into the following six categories according to processing technique: white, yellow, green, oolong, black, and dark (postfermented tea) teas (Zhang et al., 2013). White tea is the rarest and undergoes the least amount of processing, with only a prolonged-withering and drying process in its manufacture (Dai et al., 2017). The processing of yellow tea involves the partial fermentation of collected leaves, followed by further wilting,

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Chemical composition, antioxidant activity and antitumor activity of tumorous stem mustard leaf and stem extracts

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ABSTRACT
The swollen succulent stem of tumorous stem mustard (*Brassica juncea* var. *tumida* Tsen et Lee) is the raw material in the processing of Chinese *Fuling* zhàcài. We found that total polyphenols and flavonoids contents of tumorous stem mustard leaf extracts (TSMLE) were significant higher than that of tumorous stem mustard stem extracts (TSMSE). The percentage of isorhamnetin 5-O-hexoside, methyl quercetin O-hexoside, and luteolin O-hexosyl-O-hexosyl-O-hexoside in TSMLE were 170, 230 and 694 times higher than that in TSMSE. TSMLE presented stronger antioxidant capacity against 2,2'-Azino-bis[3-ethylbenzothiazoline]-6-sulfonic acid cationic free radical ($ABTS^+$) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radicals, and it also showed higher reducing power and ferric reducing antioxidant power. Both TSMLE and TSMSE inhibited lung carcinoma cell growth in a dose-dependent manner, while TSMLE was more effective against A549 cells than TSMSE. This is the first report indicates that tumorous stem mustard, especially its leaf, is a potential diet source in preventing of oxidative stress and cancer.

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KEYWORDS
Tumorous stem mustard; antioxidant activity; anti-tumor activity; phytochemicals; phenolics

PALABRAS CLAVE
Mostaza de tallo tumoral; Actividad antioxidante; Actividad antitumoral; Fitoquímicos; Fenólicos

Composición química, actividad antioxidante y antitumoral de extractos de hojas y tallos de la planta de mostaza de tallo tumoral

RESUMEN
El tallo hinchado y suculento de la mostaza de tallo tumoral (Brassica juncea var. tumida Tsen et Lee) es la materia prima para el procesamiento de la verdura china Fuling zhàcài. Al respecto, se constató un contenido total de polifenoles y flavonoides significativamente más alto en los extractos de hojas de mostaza de tallos tumorales (TSMLE) que en los extractos de tallos de mostaza de tallos tumorales (TSMSE). El porcentaje de isorhamnetina 5-O-hexosa, metil quercetina O-hexosa y luteolina O-hexosil-O-hexosil-O-hexosa presente en TSMLE fue 170, 230 y 694 veces mayor que en TSMSE. Asimismo, los TSMLE mostraron mayor capacidad antioxidante contra los radicales libres ABTS + y DPPH, además de un poder reductor y un poder antioxidante reductor del ion férrico más elevados. Tanto los TSMLE como los TSMSE inhibieron el crecimiento celular del carcinoma de pulmón de manera dependiente de la dosis, mientras que los TSMLE fueron más eficaces contra las células A549 que los TSMSE. Este es el primer informe que indica que la mostaza de tallo tumoral, especialmente su hoja, es una fuente dietética con potencial para prevenir el estrés oxidativo y el cáncer.

1. Introduction

Tumorous stem mustard (*Brassica juncea* var. *tumida* Tsen et Lee, Figure 1(a)), a native cruciferous vegetable crop in Asia countries, is a very important fresh and processed vegetable in winter and spring (Xie et al., 2014). The swollen succulent stem of tumorous stem mustard is the critical raw material in the processing of Chinese *Fuling* zhàcài, which is as famous as French sour-cucumber and German sweet-sour-cabbage. However, thousands of tons of tumorous stem mustard leaf was discarded in farmland per year since zhàcài become a commodity in China from 1899 (Yuan, 2016). This not only causes an environmental problem but also is a great waste of dietary resources. Although previous literature has been reported regarding phenolic compounds of tumorous stem mustard leaf (Xie et al., 2014), a large percentage of compounds present remain unknown and need to be identified before the health-promoting properties of tumorous stem mustard is properly elucidated.

Malignant neoplasms have become one of the leading causes of death, only second to heart diseases (Li et al., 2013). Among them lung cancer is now the most common cause of cancer-related deaths, which accounts for more than one million worldwide annual deaths (Lee, Kang, Jung, Kim, & Kim, 2011). Recently, it is reported that a high intake of vegetables is one of the cornerstones of a healthy diet and has been recommended to the general public to reduce the risk of cancer (Aune et al., 2017). The increasing researches also indicate that vegetal foods and nutrients play an important role in the prevention of cancer development (Key et al., 2004). In this regard, ingestion of leaf and swollen succulent stem of tumorous stem mustard may be a potential strategy for anticancer. Therefore, the main endeavor of the current study was to investigate the potential anti-proliferation activity of tumorous stem mustard leaf

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可溶性大豆多糖改善左旋肉碱诱导的小鼠小肠首过代谢

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摘　要： 目的：研究大豆可溶性多糖（soybean soluble polysaccharides，SSPS）对左旋肉碱喂养小鼠的小肠代谢、氧化应激和炎症相关蛋白表达的影响。方法：24 只雄性昆明小鼠随机分成正常组、左旋肉碱组、SSPS组3 个实验组。连续饲喂56 d后处死小鼠，测定小鼠小肠内P-糖蛋白（P-glycoprotein，P-gp）、多药耐药性蛋白（multidrug resistanceproteins，MRP）1、MRP3、白细胞介素（interleukin，IL）-1、IL-6、肿瘤坏死因子-α（tumor necrosis factor-α，TNF-α）质量浓度和尿苷二磷酸葡萄糖醛酸基转移酶（uridine diphosphate glucuronosyltransferase，UGT）活力、硫酸基转移酶（sulfotransferase，SULT）活力、丙二醛（malondialdehyde，MDA）浓度等的变化。结果：与正常组相比，左旋肉碱组小鼠小肠具有更高的P-gp和MRP3质量浓度（P＜0.05）；而SSPS可使左旋肉碱喂养小鼠小肠内P-gp质量浓度显著降低（P＜0.05），且使MRP3质量浓度轻微下降，表明SSPS可有效抑制左旋肉碱诱导的首过代谢。此外，SSPS与左旋肉碱联合处理可有效避免小鼠小肠组织MDA浓度的增加、超氧化物歧化酶活力的下降和·OH清除能力的减弱，预示SSPS可抑制长期摄入左旋肉碱诱导的氧化应激。然而，所有小鼠小肠组织的SULT和UGT活力以及IL-1、IL-6、TNF-α质量浓度没有显著变化（P＞0.05），表明过量左旋肉碱和SSPS处理不会影响II相代谢，也不会导致炎症反应。此外，代谢组学分析表明，SSPS可抑制长期过量摄入左旋肉碱导致的能量代谢及脂质代谢紊乱。结论：SSPS可以通过调控氧化应激和代谢紊乱而有效预防左旋肉碱诱导的小鼠小肠首过代谢。

关键词： 大豆可溶性多糖；左旋肉碱；首过代谢；氧化应激；炎症

Soluble Soybean Polysaccharides Ameliorate *L*-Carnitine-Induced First-Pass Metabolism in the Small Intestine of Mice

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Abstract: Objective: To study the effect of soluble soybean polysaccharides (SSPS) on intestinal metabolism, oxidative stress and inflammation-related proteins in mice fed *L*-carnitine. Methods: A total of 24 male Kunming mice were randomly divided into three groups: normal group, *L*-carnitine group and SSPS group. At the end of the 56-day feeding period, all mice were sacrificed to assess the changes in the levels of P-glycoprotein (P-gp), multidrug resistance protein (MRP) 1, MRP3, interleukin (IL)-1, IL-6, tumor necrosis factor-α (TNF-α), uridine diphosphateglucuronosyltransferase (UGT), sulfotransferase (SULT), and malondialdehyde (MDA) in the small intestine. Results: The concentrations of P-gp and MRP3 in the small intestine homogenate supernatant of mice in the *L*-carnitine group were significantly higher than that of the normal group (P < 0.05). However, SSPS significantly decreased P-gp concentration (P < 0.05), and slightly decreased MRP3 concentration in the small intestine of *L*-carnitine-fed mice, suggesting that SSPS could inhibit *L*-carnitine-induced first pass metabolism. Additionally, co-treatment of SSPS and *L*-carnitine on mice effectively prevented the increase of MDA content, the decrease of superoxide dismutase (SOD) activity, and the weakening of hydroxyl radical-scavenging capacity, indicating that SSPS could inhibit *L*-carnitine-induced oxidative stress. However, the activities of SULT and UGT, and the concentrations of IL-1, IL-6 and TNF-α in the small intestine did not differ significantly among all groups of mice (P > 0.05), suggesting that excessive *L*-carnitine and SSPS treatment did not affect the II phase metabolism or lead to inflammation.

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茎瘤芥的气体射流冲击干燥动力学及多酚降解动力学特征

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摘 要：为了阐明气体射流冲击干燥过程中茎瘤芥的干燥动力学和多酚降解动力学特征，分别在40、50 ℃和60 ℃下对茎瘤芥进行气体射流冲击干燥，利用8 个薄层干燥模型探究干燥动力学特征；利用4 个反应动力学模型探究茎瘤芥多酚单体的降解动力学特征。结果表明：与热风干燥相比，气体射流冲击干燥对茎瘤芥的干燥效率更高且所干燥茎瘤芥褐变程度更轻。茎瘤芥的干燥速率随着气体射流冲击干燥温度的升高而增加，该过程的茎瘤芥水分散失行为可以用Modified Page模型进行描述和预测。液相色谱-质谱联用分析发现气体射流冲击干燥会导致茎瘤芥中对香豆酸、阿魏酸、芸香柚皮苷、柚皮苷、橙皮苷、枸橘苷和橙皮素的降解。其中，橙皮苷、芸香柚皮苷、枸橘苷、柚皮苷、橙皮素和对香豆酸的降解符合二级反应动力学，且显著影响茎瘤芥的抗氧化活性。气体射流冲击干燥过程中，茎瘤芥多酚的降解是典型的非自发吸热反应。本研究为进一步改进茎瘤芥的气体射流冲击干燥品质提供了理论参考。

关键词：茎瘤芥；气体射流冲击干燥；干燥特性；多酚；降解

Drying Kinetics and Polyphenol Degradation Kinetic Characteristics in the Swollen Succulent Stem of Tumorous Stem Mustard during Air-Impingement Jet Drying

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Abstract: To elucidate the characteristics of drying kinetics and polyphenol degradation kinetics in the swollen succulent stem of tumorous stem mustard during air-impingement jet drying, the drying was carried out at 40, 50 and 60 ℃. The drying kinetic data were fitted to eight thin-layer drying models. The kinetic characteristics of the degradation of monomeric polyphenols were studied using four reaction kinetics models. The results showed that air-impingement jet drying could result in higher drying efficiency and lighter browning as compared with hot air drying. The drying rate was increased with drying temperature. The Modified Page model could be used to describe and predict the dehydration behavior. Liquid chromatography-mass spectrometry analysis showed that coumaric acid, ferulic acid, narirutin, naringin, hesperidin, lyciferin and hesperidin degraded during the drying process. The degradation of hesperidin, narirutin, lyciferin, pomelin, hesperidin and coumaric acid conformed to second-order reaction kinetics, and seriously affected the antioxidant activity. The degradation of polyphenols taking place during the drying process was a typical nonspontaneous and endothermic reaction. This study provides a theoretical reference for further improving the air-impingement jet drying of tumorous stem mustard.

Keywords: tumor stem mustard; air-impingement jet drying; drying characteristics; polyphenols; degradation
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