Nutrition and Diet Research Progress

PEPPERS

Nutrition, Consumption and Health

Mario Alfonso Salazar
Jose Miguel Ortega
Editors

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NUTRITION AND DIET RESEARCH PROGRESS

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MARIO ALFONSO SALAZAR
AND
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PREFACE

This book present current research in the study of the nutrition, consumption and health effects of peppers. Topics discussed include the beneficial effects and mechanism of action of pepper capsaicinoids; the effect of different factors on parameters of pepper fruit quality; extraction of bioactive compounds from capsicum oleoresin; the effects of pre-treatment, drying method, and temperature on drying kinetics and quality of peppers; and the consumption of peppers in Brazil and its implications on nutrition and health in humans and animals.

Chapter 1 - Since long ago of thousand years, pepper fruit berries have been used as traditional medicines in tropical and subtropical zones of especially Asia, and now used very common as household spices worldwide. Especially, in the traditional medicine, the peppers have been administered for their prevention, improvement and treatment of diseases such as gut, epilepsy and various pains including menorrhalgia in India, southern China and their surrounding areas. Their phytochemicals of pepper fruits contains their diverse components such as terpenoids and flavonoids starting with a typical alkaloid piperine. Then, the purpose of this review is to describe the correlation of their recent health effects on their treaments and preventions with the phytochemicals having their chemical structures in peppers, based on their evidences.

Chapter 2 - The main function of the diet is to provide individuals with enough nutrients to supply metabolic needs. Vegetables contain a minor set of bioactive compounds, also named dietetic phytochemicals, which although not essential for growth and / or development, provide important health benefits. Moreover, these bioactive compounds may have the ability to decrease the risk of developing certain diseases. This is the case of the capsaicinoids, major pungent ingredients of hot peppers belonging to capsicum genus. This family of bioactive compounds consists of capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homodihydrocapsaicin, and homocapsaicin. Among them, capsaicin is the main pungent component of chili peppers and the spicy ingredient in many dietary supplements. Capsaicin regulates lipid and carbohydrate metabolism, thermogenesis, vascular function and blood pressure. In pathological disorders such as diabetes, obesity, dyslipidaemia, hypertension and cancer capsaicin has been associated with potential benefits. Capsaicin exerts most of its effects through the capsaicin receptor TRPV1, a cation channel belonging to the transient potential receptor family. Activation of TRPV1 in adipocytes prevents adipogenesis and in prostate cancer cell lines, capsaicin induces cell cycle arrest and apoptosis. Additionally, this compound may exert antiproliferative effects by a TRPV1 receptor-independent mechanism. This review provides highlights on the potential role of the capsaicinoids from peppers as chemopreventive and chemoprotective agents of health, and addresses the molecular and cellular events triggered by them, with a main focus on capsaicin.

Chapter 3 - Pepper is an important agricultural crop, not only because of its economic importance, but also by its nutritional value. Pepper fruits are an excellent source of natural colours and antioxidant compounds. The intake of these compounds in food is regarded as an important health-protecting factor. Pepper consumption has been recognized as contributing to the prevention of widespread human diseases, including cancer and cardiovascular diseases, when taken daily in adequate amounts.

A wide spectrum of antioxidant compounds is found in pepper fruits, the most important being vitamin C and several carotenoids. The most important phenolic compounds in pepper are flavonoids: anthocyanins and flavonols. Flavonoids are involved in the organoleptic properties of fruit and vegetables, such as taste and colour.

Related with the oxidation of phenolic compounds are the oxidative enzymes. Peroxidase (POD; EC 1.11.1.7) is an oxydoreductase enzyme involved in enzymatic browning. Besides being an important factor in the physiology of plants, this enzyme is of great interest in food technology because of this influence of raw and processed fruits and vegetables. POD is also of concern to food processors because of its high termostability.

In general, the physicochemical parameters of fruits, their flavour and nutritional properties are affected by the maturation stage and type of agricultural practice (organic and conventional). It has also been described the influence of a commercial product, Biopron^{R}, consisting of the bacteria

Azospirillum brasilense and *Pantoea dispersa* on the fruit quality of sweet pepper under limited nitrogen supply.

Scientific information summarized in this review supports many potential health benefits of pepper, and the effect of different factors on parameters of pepper fruit quality: phenolic compounds, vitamin C, carotenoids, colour, peroxidase activity, and capsidiol activity.

Chapter 4 - The natural food colorants obtained from peppers, paprika powder and oleoresin, can be used as a natural source of pigments with a wide range of applications in medicine and cosmetic, besides in food industry. Within these pigments, carotenoids and capsaicinoids are the most important. Carotenoids pigments are the responsible of colouring capacity of paprika powder and oleoresin, and they are always present independently of the type of pepper used to produce those products. Capsaicinoids pigments can only be found when hot peppers are used, and hence, they are the responsible of the pungent capacity of paprika powder and oleoresin.

Although there are different ways to enrich these pigments from paprika or oleoresin employing organic solvents, the subsequent use of these pigments for human consumption has focused the attention to extract them by means of a "green solvent" such as supercritical CO_2 (sc-CO_2). In this way, supercritical fluid extraction can be used to fractionate the liquid oleoresin obtaining an extract enriched in capsaicinoids and a raffinate enriched in carotenoids. In fact, depending on applied pressure and temperature, enriched oleoresins of different qualities can be obtained to use them with different applications. Besides, all the collected extracts and raffinates are free of remaining solvents and can be used directly without further refining, proving the advantages of the employ of supercritical fluids to obtain bioactive compounds from Capsicum annuum.

Chapter 5 - Large quantities of pepper are produced during periods of harvest and this production is limited to certain seasons and localities. A considerable portion of the quantity produced is wasted due to lack of appropriate processing technologies. Also pepper is a perishable crop due to its high moisture content, which results in post-harvest losses which can be as high as 30%. Drying is one of the common methods of food preservation and it is carried out traditionally using sun drying. Products of low quality are usually obtained using this drying process due to its long drying times and this has resulted in the need for alternate drying processes which include solar and hot-air drying methods. Drying as a process generally leads to the modification of the properties of pepper due to the drying conditions especially temperature and this causes quality degradation. A study was carried out to determine the effectiveness of blanching as a pretreatment and solar and oven drying methods by comparing with sun drying in order to establish the most favorable drying condition in terms of drying kinetics and dried product quality. Quality parameters were nutritional composition and vitamin A and C content as well as calcium and Iron content. The pretreated samples had lower drying times compared with the untreated while solar and oven drying processes gave lower drying times when compared with sun drying. The moisture diffusivity of pretreated solar and oven dried pepper was the lower than that of untreated sun dried pepper. This indicates that the resistance to water loss during sun drying is reduced by the use of pretreatment and the alternate drying methods considered in this study. Pretreating pepper before drying was observed to result in dried pepper with higher nutritional composition but lower values of vitamins when compared with untreated pepper. The effect of pretreatment on the mineral content of the final dried pepper was however observed to be less significant than that of the drying method.

Chapter 6 - The consumption of habanero pepper (*Capsicum chinense* Jacq.) is increasing worldwide due to its high pungency levels. This plant grows and develops adequately in hydroponic cultures, allowing the production of high quality pods; however, variations in capsaicin contents can occur due to the mineral composition of the nutritive solution. In fact, the authors have previously observed that in hydroponically-cultured habanero pepper plants, nitrate doses affected capsaicin contents in pods, whereas potassium had a positive effect on pod yield. Moreover, capsaicin levels in placentas correlated with those of nitrate. In here, the authors analyze the content of macro- and micronutrients in pods of habanero peppers cultured under different nitrate doses, ranging from 1 to 30 mM, or potassium in concentrations between 1 and 12 mM. Data revealed that, under the assayed conditions, nutrient contents in pods from plants cultured on high potassium concentrations presented the highest values. However, no variations in capsaicin levels were observed. Interestingly, although nitrate modified capsaicin contents in pods, the highest values were found in those which did not presented the highest nutrient levels. No signs of evident nutrient deficiency were noticed under any of the conditions assayed. These data suggest that in habanero pepper capsaicin accumulation does not require high nutrient contents.

Chapter 7 - Plants in the *Capsicum* genus has widespread acceptance around the word as a food and as source of spices. They provide essential antioxidant vitamins, including the A, C and E for most of the word population. Red peppers belong to the oldest and most important natural colorants of foods. They are considered to be a good source of various nutritional compounds, such as carotenoids, flavonoids and mineral elements. Carotenoids from paprika products have been consider valuable sources of anti-tumor action and chemopreventive agents in chemical carcinogenesis. The group of pungent components, peculiar to the fruits of *Capsicum* plants is called capsaicinoids. These compounds have strong physiological and pharmacological properties. In addition to that, that they are widespread as a neuropharmacological component in medical products, since capsaicin has great medical value and has been reviewed its effect on the treatment of painful conditions such as rheumatic diseases, cluster headache, painful diabetic neuropathy, postherpetic neuralgia, etc. In Brazil, several works have been developed in the last years to find new uses for peppers. Antifibrotic effects were found for *C. baccatum* species. Essential oils from *C. frutescens* have been used as an alternative to growth promoters based on antibiotics used in animal diets, mainly due to its antimicrobial potential and immunomodulatory properties. Extracts of four peppers from the genus *Capsicum*, located in the metropolitan region of Porto Alegre, Rio Grande do Sul State, Brazil, were assessed in vitro cultures and showed bacterial inhibition activity and bacterial inactivation activity against *Staphylococcus aureus* (25923), Enterococcus faecalis (19433), *Salmonella enteritidis* (13076), and *Escherichia coli* (11229). The Brazilian peppers named cumari, cambuci, and malagueta showed antioxidant properties and can be used as natural antioxidant agents in food preparations. Chicken soup prepared with dedo-de-moça pepper developed less bacterial activity when compared soup made with other condiments. Male athletes feed with 10 grams of red pepper included in their breakfast each morning reported increase in respiratory exchange ratio and blood lactate concentration on both at rest and during exercise periods. This result suggested that pepper increases metabolism of carbohydrates. The use of *Capsicum* as additive phytogenic in the diet of dairy cattle increases the number oferythrocytes, leukocytes, lymphocytes andmonocytes. In addition to that, their use in the diet of dairy cattle also improves positive social behavior and physiological parameters, such as heart beats. All these aspects will be explored in this following chapter.

CONTENTS

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Chapter 1

THE HEALTH EFFECTS OF PEPPERS BASED ON THEIR EVIDENCES

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ABSTRACT

Since long ago of thousand years, pepper fruit berries have been used as traditional medicines in tropical and subtropical zones of especially Asia, and now used very common as household spices worldwide. Especially, in the traditional medicine, the peppers have been administered for their prevention, improvement and treatment of diseases such as gut, epilepsy and various pains including menorrhalgia in India, southern China and their surrounding areas. Their phytochemicals of pepper fruits contains their diverse components such as terpenoids and flavonoids starting with a typical alkaloid piperine. Then, the purpose of this review is to describe the correlation of their recent health effects on their treaments and preventions with the phytochemicals having their chemical structures in peppers, based on their evidences.

Keywords: Piper nigrum, Piperine, Vanilloid receptor, Antioxidant activity, Enhancement of gut

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ABBREVIATIONS

piperine (1-peperoylpiperidine, *1*)
α-pinene (*2*)
linalool (*3*)
N-isobutyl-(2E,4E)-tetradeca-2,4-diamide (*N*-tetra, *4*)
capsaicin (*5*)
resiniferatoxin (*6*)
zingerone (*7*)
capsazepine (*8*)
eugenol (*9*)
ruthenium red (RR, *10*)
scutigeral (*11*)
acetyl-scutigeral (*12*)
ovinal (*13*)
neogrifolin (*14*)
methyl-neogrifolin (*15*)
anandamide (*N*-arachidonoylethanolamide, AEA. *16*)
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12-(*S*)-hydroperoxyeicosatetraenoic acid (*18*)
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sabinene (*138*)

1. INTRODUCTION

From old times, the fruits of black and white pepper (*Piper nigrum*) (Photos 1,2,3) have been very commonly used as household spices worldwide.

By today, the diverse phytochemicals have been found in pepper seeds. For example, in 2005, a group of H.E.J. Research institute of Chemistry, International Centre for Chemical Sciences, University of Karachi, Karachi-75270, Pakistan studied their phytochemical in the pepper seed extract. By the gas chromatographic and gas chromatography-mass spectrometric analysis, 14 compounds including 11 novel compounds were confirmed [1].