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Cucurbita

Biology, Distribution and Habitat

Elias D. Kerrick
Editor

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CUCURBITA

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ELIAS D. KERRICK
EDITOR

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PREFACE

Mexico is the center of origin, domestication, and diversification of four cultivated species of cucurbits: *Cucurbita pepo* L., *C. ficifolia* Bouché, *C. moschata* (Duch. ex Lam.) Duch. Ex Poir. and *C. argyrosperma* Huber. *Cucurbita: Biology, Distribution and Habitat* examines these cucurbits which exhibit high intraspecific diversity.

The authors also explore DNA barcoding, a well-established technique to identify and establish evolutionary links and gaps in plants, as well as map their medicinal properties.

Studies show that *Cucurbita ficifolia* has antihyperglycaemic, antilipidemic, antioxidant, anti-tumor, hepatoprotective, anti-inflammatory, antimicrobial and anthelmintic properties and has beneficial effects on cancers, cardiovascular disease, diabetes and obesity. As such, the different effects of *Cucurbita ficifolia* on non-communicable diseases are discussed.

The pumpkin, a common vegetable found in climatic regions around the world, belongs to the family *Cucurbitaceae*. The closing chapter discusses the uses of pumpkin flour in the food industry.

Chapter 1 - Mexico is the center of origin, domestication, and diversification of four cultivated species of cucurbits: *Cucurbita pepo* L., *C. ficifolia* Bouché, *C. moschata* (Duch. ex Lam.) Duch. Ex Poir. and *C. argyrosperma* Huber. These cucurbits exhibit high intraspecific diversity and are part of the food culture of more than 60 indigenous groups settled in

Mexico. All of these indigenous groups recognize these cultivated cucurbits using specific names in local languages; for example, in the Mixteco language, shikin-iñu, chompa, shikin-ñaami and shikin-tinduyu refer to the species *C. pepo*, *C. argyrosperma*, *C. moschata* and *C. ficifolia*, respectively. Commonly, cucurbits are sown in association with maize and beans into the traditional 'milpa' system, backyards or orchards for easy access to edible fruits, flowers and tender shoots; moreover, the seeds of the mature fruits are part of indigenous-cultural gastronomy. Every crop cycle, farmers of the same and neighboring communities select and exchange cucurbit seeds for cultivation, thus preserving the highest on-farm phenotypic and genetic diversity of cultivated cucurbits in the Mesoamerican region, which features high species diversity. In addition to food use, the leaves, stems, fruits or seeds of cucurbits are used in traditional medicine to treat skin damage and liver, kidney or urinary problems, and they exhibit hypoglycemic and antidiabetic properties. Additionally, water-ground seeds are used as a vermifuge. The composition of the fruits (pulp), flowers and seeds contain essential nutritional and nutraceutical properties for human health. Experimentally, through biological models with mice or in in vitro cell culture, extracts or foods derived from the stems, leaves or fruits of cucurbits have shown hypoglycemic, anti-obesity, anti-adipogenic, antilipogenic, anti-inflammatory, and anticancer effects, as well as beneficial effects for the treatment of urinary tract disorders. To date, the chemical composition of wild species related to the cultivated forms of these fruits has not been determined in detail.

Chapter 2 - Flora play a vital role in our ecosystem. Their therapeutic potential has been explored since ancient times. They serve as a promising resource due to their medicinal properties which significantly impact human health. DNA bar-coding is a powerful, rapid and cost-effective technique for species identification and authentication of taxonomic attribution of herbal products. The main use of this tool is to catalogue organisms in a specific taxonomic group. In plants, identification is strictly based on the concept of macro and micro morphology. It has various applications in the field of ethno medicine, nutritional and pharma industry. Hence, DNA barcoding is a well-established technique to identify and establish the links and gaps

while tracing the evolutionary link within the family as well as mapping their medicinal properties useful for mankind.

Chapter 3 - Traditional medicine is considered in the treatment of numerous diseases, particularly non-communicable diseases (NCD). Recent studies have reported the beneficial effects of some herbs in treatment or prevention of NCDs pathogenesis or symptoms. Medicinal plants as supplementary methods can be used to reduce the complications of the chronic diseases. There are a lot of plants that are considered as experimental treatment for NCDs. Some of their active compounds are mucilage gum, glycans, flavonoids, triterpenes, and alkaloids. One of these plants is *Cucurbita ficifolia* (Cucurbitaceae), which traditionally has been used in Asia. It is popularly known as pumpkin. Studies showed that *Cucurbita ficifolia* has antihyperglycaemic, antilipidemic, antioxidant, anti-tumor properties, hepatoprotective, anti-inflammation, antimicrobial and anthelmintic potential and has beneficial effects on cancers, cardiovascular disease, diabetes and obesity. These activities were investigated for the most widely used cucurbitacins in vivo and in vitro studies. However, the mechanisms of these actions are unknown and further exploratory studies are needed to investigate the effect of Cucurbita on prevention and/or therapy of NCDs. In this chapter, the authors discussed the different effect of *Cucurbita ficifolia* (Cucurbitaceae) on common NCDs.

Chapter 4 - The pumpkin belongs to the family Cucurbitaceae, a common vegetable found in climatic regions around the world. Species of *Cucurbita maxima* and *Cucurbita moschata* are the most cultivated species for exhibiting an excellent added value to agribusiness. They are excellent sources of B-complex vitamins (B1, B2 and B5), vitamin C, dietary fiber and minerals such as phosphorus, potassium, calcium, sodium, magnesium and iron, and are distinguished by carotenoids, mainly β-carotene (activity pro-vitamin A), compounds involved in their coloring. Pumpkin flour is the main processed pumpkin product emerging as an alternative to reducing losses and increasing waste utilization. In the food industry, the use of pumpkin flour can be attributed to several factors, including long storage stability, ease of the storage, and important technological, nutritional and functional aspects, and could be applied to various products such as bread,

soups and instant noodles. Thus, a pumpkin flour opens a range of opportunities for the development of new products, at this stage of production there is an application of several tools, those that are analyzed through sensory evaluation, which plays a relevant role in the evaluation of food products of relevant use, even a standardization and evaluation of the quality level. Thus, the sensory analysis technique offers different types of tests - discriminative, affective and descriptive, which are recommended according to the product and end-use. The descriptive tests (sensory profile description) and discriminative tests (the measurement of differences in perception) are the most used in the development of new products.

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Chapter 1

TRADITIONAL PRODUCTION SYSTEMS, PHYTOCHEMICAL COMPOSITION OF FRUIT, SEEDS AND FLOWERS, AND NUTRITIONAL-NUTRACEUTICAL POTENTIAL OF FOUR MEXICAN CUCURBITS

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ABSTRACT

Mexico is the center of origin, domestication, and diversification of four cultivated species of cucurbits: *Cucurbita pepo* L., *C. ficifolia* Bouché, *C. moschata* (Duch. ex Lam.) Duch. Ex Poir. and *C. argyrosperma* Huber. These cucurbits exhibit high intraspecific diversity and are part of the food culture of more than 60 indigenous groups settled in Mexico. All of these indigenous groups recognize these cultivated cucurbits using specific names in local languages; for example, in the Mixteco language, shikin-iñu, chompa, shikin-ñaami and shikin-tinduyu refer to the species *C. pepo*, *C. argyrosperma*, *C. moschata* and *C. ficifolia*, respectively. Commonly, cucurbits are sown in association with maize and beans into the traditional 'milpa' system, backyards or orchards for easy access to edible fruits, flowers and tender shoots; moreover, the seeds of the mature fruits are part of indigenous-cultural gastronomy. Every crop cycle, farmers of the same and neighboring communities select and exchange cucurbit seeds for cultivation, thus preserving the highest on-farm phenotypic and genetic diversity of cultivated cucurbits in the Mesoamerican region, which features high species diversity. In addition to food use, the leaves, stems, fruits or seeds of cucurbits are used in traditional medicine to treat skin damage and liver, kidney or urinary problems, and they exhibit hypoglycemic and antidiabetic properties. Additionally, water-ground seeds are used as a vermifuge. The composition of the fruits (pulp), flowers and seeds contain essential nutritional and nutraceutical properties for human health. Experimentally, through biological models with mice or in in vitro cell culture, extracts or foods derived from the stems, leaves or fruits of cucurbits have shown hypoglycemic, anti-obesity, anti-adipogenic, antilipogenic, anti-inflammatory, and anticancer effects, as well as beneficial effects for the treatment of urinary tract disorders. To date, the chemical composition of wild species related to the cultivated forms of these fruits has not been determined in detail.

Keywords: milpa system, local seed supply, wild relatives, bioactive compounds, functional food

1. INTRODUCTION

In Mexico, wild and cultivated cucurbits (*Cucurbita* spp.) have evolved since pre-Columbian times, and it is the center of the origin and diversity of

141 taxa (124 wild and 13 cultivated); moreover, there is evidence of forms of cucurbits in ancient vessels, engraved in stone, in codex and in archaeobotanical remains (Whitaker & Cutler 1971; Whitaker 1981; Lira-Saade 1995; Vela 2010). The oldest archaeological records correspond to *C. pepo* L. in 8,000 B.C., followed by *C. argyrosperma* Huber in 7,000 B.C. and *C. moschata* (Duch. Ex Lam.) Duch. Ex Poir from 6,900 to 5,500 B.C. The most recent archaeologically recorded cucurbit in this region is *C. ficifolia* Bouché in 700 A.D., although its oldest record was in Huaca Prieta, Peru in 3,000 B.C. (Whitaker & Cutler 1971; Whitaker 1981). This historical background has conferred elements of culture, worldview and gastronomy within the relation of humans with cucurbits in more than 60 ethnic groups in Mexico; therefore, cucurbits are an essential part of Mexican cuisine and culture.

C. argyrosperma, C. moschata, C. pepo and *C. ficifolia* are cultivated widely in traditional production systems and are of high economic, food and biocultural importance in Mexico. These species are distributed in dry, semidry, temperate, transitional, subtropical and tropical regions and are sown in the ‘milpa’ polyculture, in backyards and in orchards. In general, there are three alternative forms of traditional planting: in the first case, seeds of corn, beans and pumpkin are mixed and sown; in the second case, seeds are not mixed, but every 3 to 6 m, pumpkins are sown in the same place as the corn and beans; and in the third case, corn and beans are first planted, and, after emergence, pumpkins are sown. In the 'milpa' system, it is common to find one to three species of cucurbits with high variability in fruit shape, weight and size and in skin and pulp colorations (Canul-Ku et al. 2005; Basurto-Peña et al. 2015; Hernández-Galeno et al. 2015; Molina-Anzures et al. 2016; Ríos-Santos et al. 2018).

Many parts of the *C. argyrosperma, C. moschata, C. pepo* and *C. ficifolia* plants are consumed, including the leaves, young stems, immature and ripe fruits, and seeds, in different traditional dishes. In addition to food use, in traditional medicine, the leaves, stems, fruits and seeds have been used to treat skin damage and liver, kidney or urinary tract problems and also exhibit hypoglycemic and antidiabetic activities; additionally, water-ground seeds are used as a vermifuge (Lira-Saade & Montes-Hernández