

UNIVERSITI PUTRA MALAYSIA

NUTRIENT COMPOSITION, ANTIOXIDANT ANDANTIPROLIFERATIVE PROPERTIES OF CHILLI AND TOMATOCULTIVATED BY FERTIGATION AND CONVENTIONAL METHODS

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By

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Chilli (*Capsicum annuum*) and tomato (*Lycopersicon esculentum*) are two fruittype vegetables which are commonly found in multiethnic Malaysians' daily menu. They are widely consumed, easily available and edible in a variety of ways. Chillies and tomatoes which are found in the local markets are usually grown by farmers using the conventional way of cultivation, i.e. soil-based method. Fertigation is a relatively new cultivation technique in Malaysia which uses nutrient solution for the growth of the plants instead of relying on the soil as the nutrient provider.

For this research, both chilli and tomato plants were cultivated in MARDI and the green and red fruits of both plants were later analysed in UPM. Proximate analyses were carried out to determine the content of macro and micronutrients of the individual plants. Their antioxidant activities



determined by Beta-carotene bleaching and DPPH Assay, and antiproliferative properties (MTT Assay) were also determined. All the data of the individual plant was later compared between the two cultivation methods as well as between green and red fruits of the plants. Overview of showed significant differences in the content of certain results macronutrients. Significant differences were exhibited in the contents of antioxidant vitamins (A, C and E) of both plants. Generally, the contents of minerals in the samples were not significantly different when compared between cultivation techniques. On the contrary, the differences were significant between green and red fruits of the plants. Lycopene, as well as total phenolics contents were significantly different between conventional and fertigation red tomato. Chilli and tomato in both cultivation methods showed antioxidant activities but they were not significant in low concentrations. The crude ethanolic extracts of both plants did not display potent antiproliferative properties, since IC₅₀ values were only obtained from one cancer cell lines, i.e. cervical cancer (HeLa) out of five tested at 5- $100 \,\mu g/ml$ concentration range.

Therefore, it can be generalized that green and red chilli, as well as green tomato cultivated using fertigation technique produce nutritionally higher quality of yields, whereas conventional red tomato is of higher quality



compared with its fertigation counterpart. Conclusively, fertigation produces nutritionally superior yields than that of conventional.



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KOMPOSISI NUTRIEN, ANTIOKSIDAN DAN SIFAT ANTIPROLIFERATIF CILI DAN TOMATO YANG DITANAM DENGAN KAEDAH FERTIGASI DAN KONVENSIONAL

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Cili (*Capsicum annuum*) dan tomato (*Lycopersicon esculentum*) merupakan dua sayuran jenis buah yang lazim ditemui dalam menu harian rakyat Malaysia pelbagai etnik. Penggunaan kedua-duanya rencam, mudah diperolehi di pasaran dan dijual pada harga yang mampu dibeli oleh segenap lapisan masyarakat. Cili dan tomato yang didapati di pasaran biasanya ditanam secara konvensional, iaitu menggunakan tanah. Fertigasi merupakan satu kaedah penanaman yang agak baru di Malaysia yang menggunakan larutan nutrien dan tidak lagi bergantung kepada tanah untuk membekalkan nutrient bagi pertumbuhan tanaman.

Dalam kajian ini, pokok cili dan tomato ditanam di MARDI digunakan. Buah cili dan tomato muda dan masak ini kemudiannya dianalisis di UPM. Analisis proksimat dijalankan untuk menentukan kandungan makro dan



mikronutrien setiap tanaman tersebut. Aktiviti antioksida (pelunturan betakaroten, Asai DPPH) dan sifat antiproliferatif (Asai MTT) juga ditentukan. Data yang diperolehi daripada setiap tanaman ini dibuat perbandingan antara kedua-dua jenis kaedah penanaman serta di antara buah yang muda dengan yang masak.

Secara keseluruhannya, keputusan menunjukkan perbezaan yang signifikan bagi kandungan beberapa makronutrien tertentu. Perbezaan yang signifikan ditunjukkan dalam kandungan vitamin antioksida (A, C dan E) bagi keduadua tanaman. Amnya, kandungan mineral dalam semua sampel tidak berbeza secara signifikan apabila perbandingan dibuat antara teknik penanaman. Walau bagaimanapun, buah yang muda menunjukkan perbezaan yang signifikan apabila dibandingkan dengan buah yang masak. Kandungan likopen dan fenolik juga menunjukkan perbezaan yang signifikan. Cili dan tomato konvensional dan fertigasi mempunyai aktiviti antioksida, tetapi pada kepekatan yang rendah, kuasanya juga rendah. Ekstrak kasar kedua-dua tanaman ini juga tidak mempamerkan sifat antiproliferatif yang baik, memandangkan nilai IC₅₀ (kepekatan yang merencat pertumbuhan sel kanser sebanyak 50%) diperolehi daripada satu sel sahaja, iaitu kanser serviks (HeLa) daripada lima jenis sel kanser yang diuji pada julat kepekatan 5-100 μ g/ml.

Berdasarkan hasil kajian, umumnya cili hijau dan merah serta tomato hijau yang ditanam menggunakan teknik fertigasi memberi hasil yang lebih bermutu tinggi daripada segi zat pemakanannya, manakala tomato merah yang ditanam secara konvensional lebih bermutu daripada tomato merah fertigasi. Namun bolehlah disimpulkan bahawa, secara keseluruhannya, teknik penanaman fertigasi membuahkan hasil yang mempunyai nilai pemakanan yang lebih tinggi berbanding teknik konvensional.



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CHAPTER 1

INTRODUCTION

Chilli (*Capsicum annuum*) and tomato (*Lycopersicon esculentum*) are two fruittype vegetables which are commonly found in multiethnic Malaysians' daily menu. They are widely consumed, easily available and affordable to all walks of life. In addition to that, they are edible in a variety of ways, either eaten fresh or cooked, and also used creatively as food garnishing.

Chillies and tomatoes which are found in the local markets are usually grown by farmers using the conventional way of cultivation, i.e. soil-based method. This method is called "geoponic system", which literally describes the roots of the plant creeping in the soil. Even though this method seemed to satisfy the demand for these fruit-type vegetables in the market, research are ongoing to produce yields that are of high quality and more economical to produce. Universiti Putra Malaysia (UPM) and Malaysian Agriculture Research and Development Institute (MARDI) are examples of organizations that are actively involved in the related research.

Hydroponic system is an alternative cultivation method to the existing geoponic system practiced in the country. Compared to the old system,



hydroponic uses nutrient solution for the growth of the plants instead of relying on the soil as the nutrient provider.

Fertigation is a new cultivation technique which is almost similar to the concept as well as the technique used in hydroponic. In Malaysia, it was pioneered by Dr. Mahamud Shahid, a senior researcher in MARDI. This method has been applied widely in other countries such as India (Dalvi *et al.*, 1998; Singandhupe *et al.*, 2002; Hebbar *et al.*, 2003), Canada (Xu *et al.*, 1995), Belgium (De Rijck & Schrevens, 1997) and Israel (Chapagain & Wiesman, 2003). In our country, it is widely applied in Cameron Highlands, certain parts of Johore, Terengganu, Kedah and Negeri Sembilan (Mahamud, 2002).

Importance of Study

Fertigation yields, specifically chilli and tomato which are produced in Malaysia have yet to be studied, specifically in terms of their nutrient composition. Even though the data could be obtained from Nutrient Composition of Malaysian Foods (Tee *et al.*, 1996), they are not representative of chilli and tomato in this study. Furthermore, the cultivar and the cultivation technique used for the plants in Tee *et al.* (1996) are unknown. In this study, fertigation yields will be compared to their conventional counterparts to determine which cultivation method produce superior yield from the perspective of their nutritional values.



Objective

General objective

To determine and compare the nutrient composition, antioxidant activities and antiproliferative property of chilli and tomato cultivated by fertigation and conventional methods.

Specific objectives

- To determine and compare the nutrient composition, antioxidant activities and antiproliferative property of green and red chillies cultivated by fertigation and conventional methods.
- To determine and compare the nutrient composition, antioxidant activities and antiproliferative property of green and red tomatoes cultivated by fertigation and conventional methods.



CHAPTER 2

LITERATURE REVIEW

Food nourishes life, and the substances in food on which life depends are the nutrients. These provide the energy and building materials for the countless substances that are essential to the growth and survival of living things (Mahan and Escott-Stump, 1996).

Plants can provide most of the nutrients required in the human diet (Tucker, 2003). Through the process called photosynthesis, green plants intercept a portion of the sunlight reaching their leaves and capture it within the chemical bonds of glucose. Proteins, fats and other carbohydrates are synthesized from this basic carbohydrate to meet the needs of the plant. Animals and humans obtain these nutrients and the energy they contain by consuming plants and the flesh of other animals (Mahan and Escott-Stump, 1996).

2.1 Chilli

Capsicum annuum L., the botanical name for chilli, belongs to the family of Solanaceae. In the Malay community, it is called "cili", "cabai" or "lada". It is reported to be originated from Central or South America (Pruthi, 1976;

