



## A Scoping Review of Melon Manis Terengganu Research Perspective in Malaysia

Mohd Fauzie Jusoh<sup>a,b</sup>, Tengku Halimatun Sa'adiah Tengku Abu Bakar<sup>b</sup>, Farah Adila Abdullah<sup>b,c</sup>, Mohd Khairul Hafifi Maidin<sup>c,d</sup>, and Muhammad Firdaus Abdul Muttalib<sup>a,\*</sup>

<sup>a</sup> Faculty of Chemical Engineering Technology, Universiti Malaysia Perlis, 02600 Arau, Perlis, Malaysia

<sup>b</sup> Faculty of Agro Based Industry, Universiti Malaysia Kelantan, 17600 Jeli, Kelantan, Malaysia

<sup>c</sup> School of Economics, Finance & Banking, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia

<sup>d</sup> Strategic Planning & Innovation Management Centre, MARDI Headquarters, Persiaran MARDI-UPM, 43400 Serdang, Selangor, Malaysia

**\*Corresponding author: [firdausmuttalib@unimap.edu.my](mailto:firdausmuttalib@unimap.edu.my)**

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### **ABSTRACT**

Melon Manis Terengganu (MMT) is an iconic and official fruit of Terengganu state, Malaysia. MMT is the new melon variety introduced to the farmers in Terengganu as one of the ways to improve their socioeconomic level. The present scoping review attempts to recognise and synthesise the published materials on MMT research and explore the research perspective of MMT. The Web of Science, Scopus, Dimensions, and Google Scholar online databases have been included in this study to screen the published peer-reviewed documents on MMT research. A total of 15 full articles (with 565 cited references) have been accessed in this study. Publication on MMT began in 2018 where most of the scholars affiliated with Universiti Sultan Zainal Abidin and Universiti Malaysia Terengganu. The scientific research on MMT is limited, and the research topics are considered emerging knowledge. Biochemistry is the leading research discipline of MMT besides food processing, postharvest, entomology, crop performance and entrepreneurship. This synthesis review contributes to the body of knowledge, especially to the new academicians and scholars, in better understanding the current research progress and possible future research direction of MMT study in Malaysia.

**Keywords:** Farmer, melon, scoping review, plant growth, socioeconomic

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### **INTRODUCTION**

Malaysia is blessed to be endowed with various natural resources for life. The agriculture sector remains an essential industry in Malaysia, contributing about 16 percent of employment (Mumuh et al., 2021). The agriculture sector contributed RM 101 billion to the country's GDP in 2019. On the other hand, the agro-food subsector contributed roughly RM 50 billion. The value of fruit production increased significantly from RM 4.3 billion in 2015 to RM 9.8 billion in 2019 (Ministry of Agriculture and Food Industries Malaysia, 2019). According to Muhammad et al. (2015), approximately 85.2 percent of rock melon farmers and 96.2 percent of watermelon or honeydew farmers have been involved in melon cultivations in Malaysia. The majority are men with an

average age between 35 – 48 years. In the global, melon is among the top 10 ranks in economic importance for the crop (Schaffer & Paris, 2016). In Malaysia, it was ranked third among the high-value crops in national agriculture policies (Muhammad & Masdek, 2016). The production of high-quality melon is expected to increase to fulfil rising global demand (Thakur et al., 2019; Wani et al., 2017). Melon is thought to have originated in Africa based on distribution, cross-breeding attempts, and genetic research (Kerje & Grum, 2000). The botanical varieties of melon can be divided into three major types: *cantalupensis*, *inodorus*, and *reticulatus* (Saltveit, 2011).

Melon Manis Terengganu (MMT), with the scientific name of *Cucumis melo*, is a variety of *inodorus* with the cultivar name of Manis Terengganu 1 (Aisyah et al., 2018) and has been announced as identical fruit of Terengganu state (Terengganu Department of Agriculture, 2021). MMT is characterised by smooth yellow-golden skin, unnetted skin, and orange coloured flesh (Muhamad et al., 2018). The sweetness level of mature MMT is around 13 - 19 °Brix with a shelf life of about two weeks from the harvesting date, depending on storage condition (Muhamad & Redzuan, 2019). An observation in the online market shows that the average price of premium quality MMT is about RM10 per kilogram. Manchali et al. (2021) demonstrated that various types of melon have good nutritional properties that benefit human health. Lester (1997) reported that melon has a high nutritional quality and health functionality since it contains a high level of vitamin C, beta carotene, and potassium and is low in fat, sodium and cholesterol. Besides that, a review by Khalid et al. (2021) showed that melon seed contains a high value of active compounds such as sterols, phospholipids, and tocopherols. The by-product of melons, especially their peel and seed, can be further developed for human health applications and biotechnology (Rolim et al., 2020).

An entity of co-operative societies known as Koperasi Pengusaha Melon Manis Terengganu Berhad (KOPMET) was established in 2018 to systematically manage MMT fruit production and farmers. The three-fold functions of KOPMET are; to supply the verified MMT seed to the members or MMT farmers, coordinate the planting schedule of MMT, and provide a platform for farmers to promote MMT inside and outside Terengganu. The producer of MMT seed (GWG Sdn Bhd) supplies the verified and high-quality MMT seed to KOPMET. Later, KOPMET provided MMT seeds to their members and MMT farmers in Terengganu. Indirectly, MMT seed can be monitored and the fruit quality is guaranteed. The Terengganu Department of Agriculture acts as a supervision body on MMT plantations in Terengganu to ensure the premium quality of MMT and standard operating procedures of MMT cultivation. Among the main planting area of MMT are Taman Kekal Pengeluaran Makanan (TKPM) Tok Dor (Besut), TKPM Rhu Tapai (Setiu) and TKPM Peradong (Kuala Terengganu) beside private farmers entire Terengganu. Mostly, melon is recommended to be planted in a controlled environment structure or under a rain shelter.

The scoping review involves knowledge synthesis and a systematic approach to map the available evidence on specific topics (Tricco et al., 2018). Munn et al. (2018) listed four main reasons for conducting the scoping review. First, to evaluate the nature of the research activity, second to disseminate research outcomes, third to identify the research gap, and fourth to decide on the necessity of conducting a systematic review. Initially, the scoping review study was applied in medicine, but it has been used nowadays in various fields and purposes (Peterson et al., 2016). The Scopus and Web of Science database recorded the first scoping review in 2003, written by Arksey (2003). Peterson et al. (2016) highlighted that the scoping study had caught scholars' attention since 2000, where more than 500 published scoping review articles were available in the literature.

Researchers across diverse knowledge domains have conducted a few reviews on melon. Most of the published studies related to narrative review with specific attention to the particular topic, as reported in Giwa and Akanbi (2020), Khalid et al. (2021), Rashidi and Gholami (2008), and Singh et al. (2021). Even though these scientific works have focused on MMT cultivars, there is still a lack of clarity on the research areas of MMT covered by researchers. Therefore, this scoping review explores the evidence and provides information on the current research progress on MMT. Besides, it also furnishes information to understand a topic better and ease decision-making towards systematic reviews or other complex syntheses. The main objective of this scoping review is to examine the research perspective of MMT in Malaysia by identifying and exploring the knowledge discipline from published research articles by scholars. Two research questions were developed to guide this study. First,

what are the article characteristics and aspects of MMT addressed in the articles? Second, what evidence is available on the knowledge discipline highlighted by scholars on MMT core research?

## MATERIALS AND METHODS

The present study was designed as scoping review and guided by Iannizzi et al. (2021). The previous version of scoping review protocols can be obtained from Arksey and O'Malley (2005), Levac et al. (2010) and Peters et al. (2015). To better understand on scoping review, Colquhoun et al. (2014) compared the Arksey and O'Malley (2005) framework to the Levac et al. (2010) improvement. The research questions developed in this study are broad-based on identifying article characteristics and exploring the knowledge discipline on MMT core research via scholarly work and peer review articles from past publications. The scoping review was selected for this study because the topic is relatively new. According to Munn et al. (2018), a scoping review is the best selection if the purpose of the study is to identify the scope of a body of literature. Based on the standard scoping review methodology of Iannizzi et al. (2021), there are five steps of methodological frameworks to conduct scoping review: i) Development of research question ii) Identification of relevant documents iii) Study selection iv) Data charting and v) Result collating, summarising and reporting. Later, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram (Tricco et al., 2018) was used to record and report the study selection process in the present scoping review, as shown in Fig. 1.

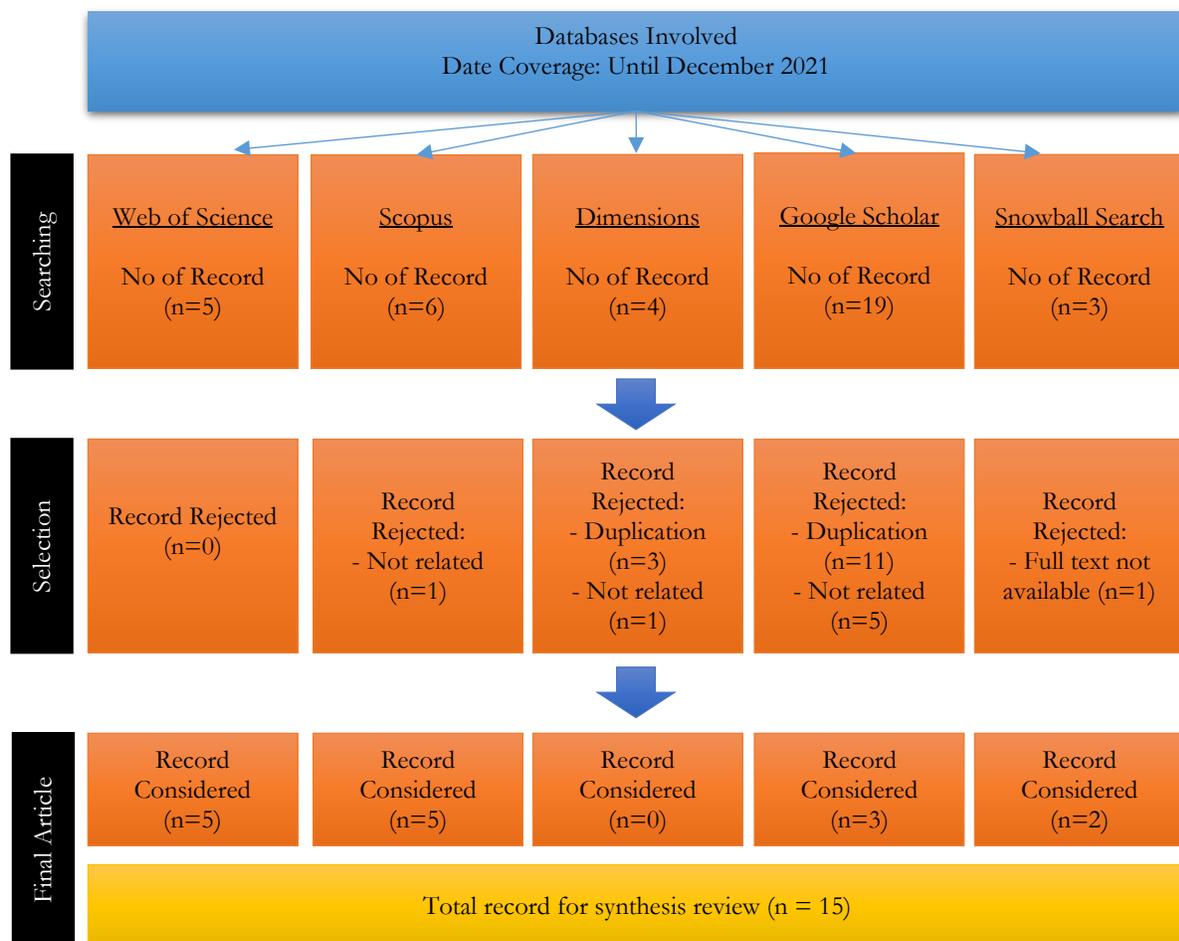


Fig. 1. The flow diagram process of the study.

## **Searching strategy**

The database of Web of Science, Scopus, Dimensions, and Google Scholar were explored in December 2021 to retrieve the relevant documents. The search processes were done by commissioning the selected keyword on all field code functions using Boolean operator without any article's restrictions on year and languages. Since the searching of the relevant documents is very specific, involves local name, and focus on the research on MMT, the keywords applied only related to the synonyms of MMT. In the Web of Science, Scopus and Dimension database, the search string of "melon manis terengganu" OR "manis terengganu melon" with all field codes was applied during data searching. By using all field code functions, the database identified the word or term occurrence and existence in any section of the articles or search category. Meanwhile, in Google Scholar search, patent and citation fields were included in searching to maximise the covering information. The references from all records were examined to find untraced articles through forward and backward snowball searching Wohlin (2014). One record related to MMT, as cited in Zainol et al. (2021), is not available in the full text and therefore, it has been excluded from this review.

## **Data extraction and selection**

The bibliographical data from Web of Science, Scopus, and Dimensions were extracted to the Excel Spreadsheet (Microsoft Office Professional Plus 2019, Version 2110) using the export function tab at the database provider. Meanwhile, the data from Google Scholar was extracted into Excel Spreadsheet using Data Miner tools, an extension of Google Chrome. The screening processes were divided into two stages. In the first stage, the record's title and abstract were independently reviewed by three authors of this article (MFJ, MKKM, MFAM). Any issues relating to inclusion criteria, exclusion criteria and discrepancies were discussed through email. After the decision had been made, full-length articles were evaluated and extracted for data synthesis (stage two). All the data were combined into a spreadsheet based on the article characteristics. The data were grouped into the same categories during the extraction process, and vital information was noted. Later, meaningful interpretations were produced from the available data.

## **Data analysis and Visualisation**

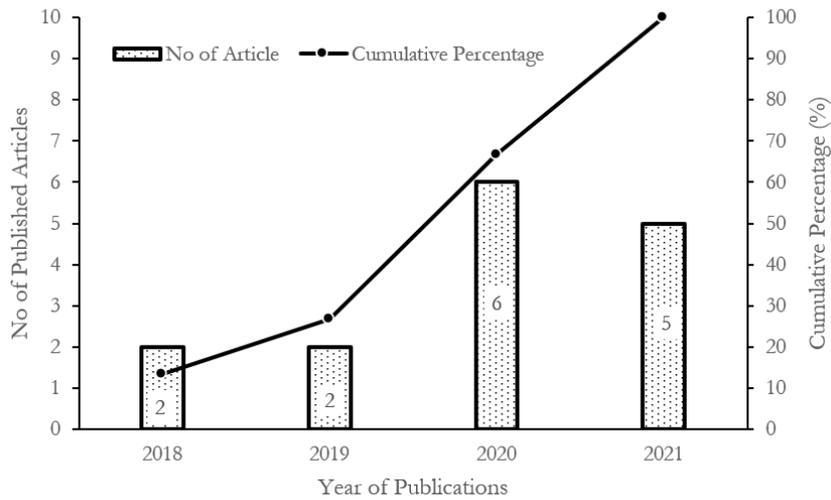
The finding from these published articles was synthesised and tabulated in the table form and graphical representation. A narrative summary was conducted to discuss the results. The title and abstract information from the selected articles further be visualised using VOSviewer Software Version 1.6.17 (van Eck & Waltman, 2021) to create a network visualisation based on the text data. However, abstracts were absent in journal articles of Aisyah et al. (2108) and Aisyah and Sembok (2020). Therefore, the conclusion section has been used to substitute the abstract section. The Thesaurus file was created to harmonise the data to avoid redundancy and keyword variation.

# **RESULTS AND DISCUSSION**

## **Article Characteristics**

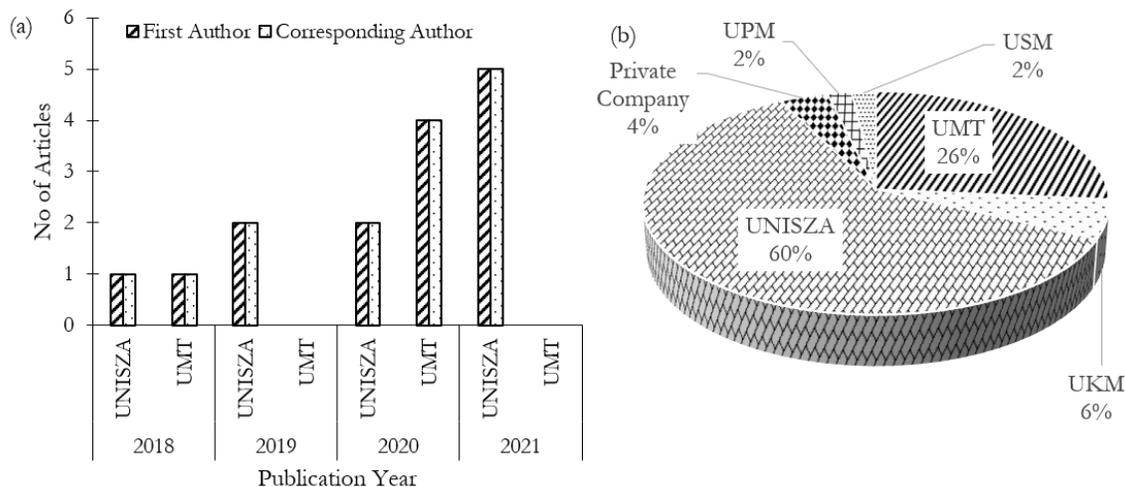
A total of 37 relevant published materials were examined and extracted from the five different databases, including the snowball searching method. Only 15 documents (with 565 references) related to MMT research were synthesised from these records. Fig. 2 shows the publication trends on MMT articles from 2018 until 2021. The first paper published on MMT was presented at a conference held in 2017 (Aisyah et al., 2018). Out of 15 documents, only two (13.33 percent) were conference papers and the rest were published in peer-reviewed journals. The research on MMT indicates increasing trends starting from the year 2018 until nowadays. The publications peaked in 2020 with six published articles. The research on MMT is classified as an emerging topic since the search record showed little evidence, but the cumulative percentage of publication numbers implied a steady increment. The scientific research might begin after about two years of MMT variety being introduced

to the farmer on 29 September 2015 in conjunction with the 110 years of the Malaysian Department of Agriculture celebration (Terengganu Department of Agriculture, 2021).



**Fig. 2.** Publications trends on MMT articles from 2018 to 2021

Based on the available records, researchers from Universiti Sultan Zainal Abidin (UNISZA) and Universiti Malaysia Terengganu (UMT) dominated the published articles with 60 percent and 26 percent, respectively (Fig. 3a). It can be seen that, the first author and corresponding author are from UNISZA and UMT affiliations. Both institutions, based in Terengganu state, began publishing MMT articles in 2018. This implied that the introduced variety had caught local researchers' attention parallel to the MMT development. However, scholars from other research universities, including Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), and Universiti Sains Malaysia (USM), were invited to collaborate on the MMT project (Fig. 3b). On the other hand, industry experts from private companies (4 percent) participated in MMT research as well. The institutions in the origin state have dominated the research on MMT since MMT is currently only planted in Terengganu by the procedures. Although no regulation prohibits planting any plant variety in any location, the mechanism of seed supply indirectly limits the MMT cultivation outside the Terengganu state. Additionally, the fruit brings the Terengganu state name, and the authorities attempt to regulate MMT cultivation standards and the quality of MMT sold in the market (Ibrahim, 2020). All published articles on MMT research were written in English for academic purposes based on the records. In agreement with Lo'pez-Navarro et al. (2015), authors prefer to write in English rather than their native language since it reaches a more scientific audience and increases the chances of visibility.



**Fig. 3.** Number of articles based on first author and corresponding author (a) and publication percentage based on institution affiliation (b)

Table 1 ranks the topmost source title and publishers in MMT research. The most active source title is Bioscience Research, published by Innovative Scientific Information & Services Network (33.33 percent). This organisation is centred in Pakistan and the journal database was indexed by Web of Science, Scopus, Directory of Open Access Scholarly Resources, Academic Journals Database and Google Scholar (Innovative Scientific Information and Services Network, 2021). Among the active local journal on MMT publications are Transactions of the Malaysian Society of Plant Physiology by Malaysian Society of Plant Physiology (13.33 percent), Journal of Agrobiotechnology by UNISZA (13.33 percent), Malaysian Applied Biology by Malaysian Society of Applied Biology (13.33 percent), Serangga by UKM (6.67 percent), The Journal of Management Theory and Practice by UNISZA (6.67 percent) and Food Research by Rynnye Lyan Resources (6.67 percent). Asian Journal of Plant Sciences (Science Alert) is another overseas journal from UAE that published one article on MMT research.

**Table 1.** The source title and publishers' ranking based on the number of articles published

Rank	Source Title	Publisher	Country of Publisher	No of Articles (Percentage) *
1	Bioscience Research	Innovative Scientific Information & Services Network	Pakistan	5 (33.33)
2	Transactions of the Malaysian Society of Plant Physiology	Malaysian Society of Plant Physiology	Malaysia	2 (13.33)
3	Journal of Agrobiotechnology	Universiti Sultan Zainal Abidin (UNISZA)	Malaysia	2 (13.33)
4	Malaysian Applied Biology	Malaysian Society of Applied Biology	Malaysia	2 (13.33)
5	Serangga	Universiti Kebangsaan Malaysia (UKM)	Malaysia	1 (6.67)
6	The Journal of Management Theory and Practice	Universiti Sultan Zainal Abidin (UNISZA)	Malaysia	1 (6.67)
7	Asian Journal of Plant Sciences	Science Alert	UAE	1 (6.67)
8	Food Research	Rynnye Lyan Resources	Malaysia	1 (6.67)

\* Some of the publishers shared the same ranking number.

Table 2 details the most prolific authors of MMT research. The majority of the leading authors hold academic positions such as senior lecturer, associate professor, and professor at UNISZA, UMT, and UKM. Surprisingly, the most prolific author in MMT research is Ying Qian Ong from UNISZA. She is currently a PhD candidate

in the Faculty of Health Science (UNISZA), where she studies the effect of MMT peel on blood sugar levels and diabetes. She has five papers on MMT research and a total of 12 publications. Based on the Google Scholar record, she is a young researcher with her first paper (Halib et al., 2018) published in 2018. Sakinah Harith, Norlia Muhamad, Norshazila Shahidan, and Mohd Razif Shahril shared the second rank of MMT publication (4 articles). These authors are affiliated with UNISZA except for Mohd Razif Shahril, who was affiliated with UNISZA before joining UKM. The total number of publications and the Google H-index range from 10 to 111 articles and 4 to 13 indexes, respectively. This group of scholars may be classified as experienced researchers, as they had received a considerable number of citations (78 to 518). Hermizi Hapidin (Google H-index = 10) from USM was ranked third since this scholar produced three articles on MMT research out of 31 recorded articles in Google Scholar. Although Amiza Mat Amin and Ho Lee Hoon shared fourth place with Wan Zaliha Wan Sembok, these two authors obtained over 700 citations. Every scholar has their research niche area where it has been developed since they started their research work. The ranking in Table 2 does not necessarily imply that the first-ranked author has greater experience than the others. They may have fewer publications in MMT research, but they may have expertise in a different knowledge domain.

**Table 2.** The most prolific authors on MMT

No	Author	Position	Department/ Affiliation	MMT#	TP*	H-Index <sup>§</sup>	TC <sup>&amp;</sup>
1	Ying Qian Ong	PhD Candidate	Faculty of Health Sciences, UNISZA	5	12	3(1)	25
2	Norlia Muhamad	Senior Lecturer	Faculty of Bioresources & Food Industry, UNISZA	4	10	4(2)	78
3	Sakinah Harith	Professor	Faculty of Health Sciences, UNISZA	4	111	13(8)	493
4	Norshazila Shahidan	Senior Lecturer	Faculty of Bioresources & Food Industry, UNISZA	4	37	6(6)	228
5	Mohd Razif Shahril	Associate Professor	Faculty of Health Sciences, UKM	4	73	13(10)	518
6	Hermizi Hapidin	Associate Professor	School of Health Sciences, USM	3	31	10(8)	383
7	Wan Zaliha Wan Sembok	Senior Lecturer	Faculty of Fisheries and Food Sciences, UMT	2	64	7(1)	185
8	Amiza Mat Amin	Associate Professor	Faculty of Fisheries and Food Science, UMT	2	54	15(10)	775
9	Ho Lee Hoon	Senior Lecturer	Faculty of Bioresources & Food Industry, UNISZA	2	36	16(10)	767

# No of articles on MMT research.

\* TP is the total publication recorded by Google Scholar as of December 2021

§ H-Index without bracket is based on Google Scholar and in the bracket based on Scopus as of December 2021

& TC is all total citations mentioned by the author profile of Google Scholar as of December 2021

## Research Disciplines of MMT

Summaries of studies on MMT research in Malaysia are depicted in Table 3. Based on the extracted data, the research discipline of MMT can be divided into six disciplines or themes; biochemistry, food processing, postharvest, entomology, crop performance and entrepreneurship. The majority of the research involved the applied science field (n=14) compared to the social science field (n=1). Biochemistry discipline (n=6) is the leading research discipline of MMT research. Researchers are interested in investigating the properties of phenolic content, flavonoids, antioxidant properties, epigallocatechin gallate, vitamins, minerals, heavy metal content and anti-inflammatory activity of MMT (Amin et al., 2020; Muhamad et al., 2018; Ong et al., 2020; Ong

et al., 2021a; Ong et al., 2021b; Ong et al., 2021c). The study analysed various fruit components, including the flesh, seed, and peel. Apart from mature fruit, the immature stage of MMT was also evaluated in a previous study. MMT immature fruit is considered waste since it is plucked out, and usually, only one fruit remains for a plant to produce high-quality fruit. Congruent to Koleboshina and Varivoda (2020), achieving a high yield of melon requires developing superior varieties and adopting novel agricultural practices.

**Table 3.** Summary of studies on MMT research in Malaysia

Publications	Study Field	Title	Research Aim	Outcomes
<b>Biochemistry (6 out of 15 articles or 40.0 percent)</b>				
Muhamad et al. (2018)	Applied Science (Experiment)	Effect of drying temperatures and extraction solvents on total phenolic, flavonoid contents and antioxidant properties of immature Manis Terengganu Melon ( <i>Cucumis melo</i> )	To study the effects of drying temperature (40, 50 and 60 °C) & 3 different solvents on the total phenolic content, total flavonoid content and antioxidant activity of immature MMT.	The study concludes that drying temperature and type of solvent affect the extraction yield of total phenolic, total flavonoid and antioxidants. The selection of temperature and solvent type depends on the requirement of food industries.
Ong et al. (2020)	Applied Science (Experiment)	Quantification of epigallocatechin gallate in Melon Manis Terengganu ( <i>Cucumis melo</i> L.) by high-performance liquid chromatography	To study epigallocatechin gallate content in different maturity levels, peel, flesh and seed of MMT.	Mature MMT peel showed the highest epigallocatechin gallate concentration of 0.042 mg/mL compared to other fruit parts.
Amin et al. (2020)	Applied Science (Experiment)	Effect of heat pretreatments on chemical and antioxidant properties of Melon Manis Terengganu ( <i>Cucumis melo</i> var. inodorus cv. Manis Terengganu 1) seed oil	To evaluate MMT seed oil's chemical and antioxidant properties respective to different heat pretreatments.	The main finding of this study is different heat pretreatments of MMT seed influenced the oil yield (11.10–15.40 percent), free fatty acid (3.55–5.04 percent), DPPH radical scavenging activity (43.06–56.08 percent), total phenolic content (0.088 -0.142 mg GAE/g) and FRAP activity (0.0723 -0.110 mmole/100 mL)
Ong et al. (2021a)	Applied Science (Experiment)	Polyphenolic profile and antioxidant activities of freeze-dried Melon Manis Terengganu peel extracts	To determine the polyphenol and flavonoid contents, polyphenolic compounds, and antioxidant activity of freeze-dried MMT peel aqueous extract.	The studied freeze-dried MMT peel aqueous extraction contains antioxidant properties with the presence of polyphenolic compounds.
Ong et al. (2021b)	Applied Science (Experiment)	Proximate compositions, physicochemical properties, polyphenolic content and antioxidant activity of spray-	To determine the proximate compositions, physicochemical	Spray-dried MMT peel aqueous extract is a weak antioxidant with negligible bioactive compounds. Hence,

		dried Melon Manis Terengganu peel	properties, polyphenolic content, and antioxidant activity of spray-dried (maltodextrins as a coating agent) MMT peel.	the drying method needs to be modified to produce high powder quality and higher antioxidant activity.
Ong et al. (2021c)	Applied Science (Experiment)	Determination of vitamins, minerals, heavy metals and anti-inflammatory activity of Melon Manis Terengganu peel	To calculate the concentration of vitamins, minerals, heavy metals, and anti-inflammatory capacity of MMT peel.	The finding explained that vitamin C was the highest (5.60 (0.04) mg/100g), and magnesium (458.72 (6.72) mg/100g) was the predominant mineral found with heavy metals concentration below the permissible limit in MMT peel. The HRBC membrane stabilisation assay and half maximal inhibitory concentration of protein denaturation assay were 35.70 (0.37) mg/mL and 5.75 (0.14) mg/mL, respectively.

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**Food Processing (4 out of 15 articles or 26.6 percent)**

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Muhamad and Redzuan (2019)	Applied Science (Experiment)	Effects of drying methods on the quality parameters of dried Manis Terengganu Melon ( <i>Cucumis melo</i> )	To investigate suitable drying method temperatures (40 °C, 50 °C and 60 °C) to preserve immature MMT.	The drying temperature of 50 °C (using a rotary dryer) was preferred to produce dried melon respected to time consumption and physicochemical quality.
Amin and Loo (2020)	Applied Science (Experiment)	Effect of incorporation of honey on chilled storage and sensory acceptance of probiotic Melon Manis Terengganu ( <i>Cucumis melo</i> var inodorus cv. Manis Terengganu 1) juice	To quantify the effect of storage conditions (28 days, 4°C) on MMT juice, MMT probiotic juice and MMT probiotic honey juice.	Based on the sensory evaluation test, the most preferred juice is MMT juice, followed by probiotic MMT juice and, finally, probiotic MMT juice with honey. At the end of 28 days of chilled storage, all samples showed decreased viscosity, increased total soluble solids, and no changes in titratable acidity.
Muhamad et al. (2020)	Applied Science (Experiment)	Physical characteristics and sensory evaluation of cookies prepared from wheat flour and immature Manis Terengganu melon flour blends	To determine the physical properties of cookies prepared by different substitution ratios of immature MMT flour.	Results revealed that cookies made from 15 percent immature MMT flour had lower hardness (1.50 kg) than without substitution (hardness = 2.97 kg). Sensory evaluation showed that the increased amount of immature MMT flour substitution decreased

the mean score for overall acceptability since the assessor did not prefer the taste.

Muhamad and Basri (2019)	Applied Science (Experiment)	Effect of osmotic dehydration on physicochemical characteristics of dried Manis Terengganu melon	To evaluate the relationship between osmotic dehydration pretreatment to physicochemical characteristics of dried immature MMT	The main finding of this study demonstrated that osmotic dehydration of MMT in sucrose solutions with added calcium lactate significantly increased weight reduction, water loss, and reduced sugar addition in the fruit.
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**Postharvest (2 out of 15 articles or 13.3 percent)**

Aisyah et al. (2018)	Applied Science (Experiment)	Effects of different storage temperatures on physicochemical characteristics and quality of Melon Manis Terengganu ( <i>Cucumis melo</i> var. Inodorus cv. Manis Terengganu 1)	To observe the response of quality, physicochemical and characteristics of MMT towards different storage temperatures.	The study shows that MMT fruit stored at different temperatures for 24 days remains acceptable to be marketed. The storage temperature of 25°C had similar internal and external quality compared to the fruit stored at low-temperature storage.
Aisyah and Sembok (2020)	Applied Science (Experiment)	The effect of different types of plant growth regulators in developing parthenocarpic Melon Manis Terengganu and improving its postharvest quality	To evaluate the best plant regulator and its effects on the development of seedless MMT.	The combination of 400 mg/L of IAA (Auxin) and 400 mg/L gibberellic acids had the potential to produce seedless MMT fruit without quality compromise.

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**Entomology (1 out of 15 articles or 6.7 percent)**

Tahir et al. (2020)	Applied Science (Field Test)	Pests and diseases incidence at different growth stages of melon manis Terengganu <i>Cucumis melo</i> var. Inodorus cv. Melon Manis Terengganu	To examine the pests and disease incidence at different growing stages of MMT cultivation.	The finding showed different pests and diseases detected at the different growing stages of MMT cultivation. Red pumpkin beetle was the most dominant pest for all growth stages, followed by melon worm during the foliage expansion stage. Leaf miner fly was prevalent during the fruit maturation stage. The most dominant diseases were Cucurbits Yellow Stunting Disorder Virus, Powdery Mildew and Verticillium wilt.
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**Crop Performance (1 out of 15 articles or 6.7 percent)**

Ong and Khandaker (2021)	Applied Science (Field Test)	Growth and development of Melon Manis Terengganu in response to seasonal variation	To compare the growth performance of MMT between dry and wet seasons.	MMT's growth performance and yield were better in the dry season than in the wet season.
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**Entrepreneurship (1 out of 15 articles or 6.7 percent)**

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Zainol et al. (2021)	Social Science (Interview)	Establishing a graduate agropreneur business model for food security: a case study of the Melon Manis Terengganu (MMT) fertigation project	To identify key elements needed for graduate agropreneurs through business model innovation.	Agropreneurs are being pushed by global competition and technological advancements to find new business structures and ways to interact in the business world. Market assurance is the prime factor in the success of an agricultural project.
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The second knowledge discipline is food processing (n=4). This category focused on the development of multiple food products derived from MMT, such as probiotic juice (Amin & Loo, 2020), MMT flour (Muhamad et al., 2020), and dried fruit (Muhamad & Basri, 2019; Muhamad & Redzuan, 2019). The researchers attempted to develop and enhance the melon's available resources to create high-value products using current food technology. Muhamad et al. (2020) demonstrated having flour from immature MMT, which is slightly different from other researchers who made flour from the melon seeds of other varieties (da Cunha et al., 2020; Ogundele, 2016). The third discipline is postharvest (n=2), constituting about 13.3 percent of the total review articles. The studies in this category focused on the MMT fruit storage temperature and seedless melon production. According to Aisyah et al. (2018), MMT stored at 25°C for 24 days showed comparable internal and exterior qualities to fruit stored at lower temperatures. Knowing this information enables farmers to plan and manage the melon harvesting season more effectively. Apart from temperature conditions, variations in atmospheric storage can have a considerable effect on melon quality (Minh, 2020; Véras et al., 2019) and biochemistry characteristics of melon, such as gene transcription (Zhang et al., 2021), microbial activity (Minh, 2020) and enzymatic activity (Véras et al., 2019). There are various effects of different storage settings on the biochemical properties of melon that could be studied to produce melon with a high preference and premium grade (Aisyah & Sembok, 2020).

The disciplines involving single articles were entomology, crop performance and entrepreneurship. Crop performance evaluation is crucial in crop production since it demonstrates the efficiency of the production process. Ren et al. (2021) discussed that different amounts of irrigation could affect photosynthesis and, eventually, crop yield. Mumuh et al. (2021) explained that climate change affects the quality and quantity of crop yields, irrigation water use, soil drainage, soil loss, organism adaptation, and pest population. They further concluded that climate change and energy usage have mixed effects on the agriculture economy (Mumuh et al., 2021). Lee and Baharuddin (2018) suggested increasing solar research applications and better management of the nitrogen and carbon cycle to reduce the effect of climatic change in Malaysian agriculture. It was discovered that simultaneous variation in rainfall and temperature reduces Malaysia's economic performance in both the short and long run. The rainfall and temperature variability harm food availability and access to food, owing to reduced agricultural product supply, commodity inflation pressure, and decreased household income (Solaymani, 2018). Reflecting on these findings, social science field research in MMT is few, and numerous aspects of the social sciences remain untapped. Recently, Zainol et al. (2021) only focused on the elements needed in business model innovation through the business model canvas and explained the relationship between business model innovation and farm profitability. Although graduate agro entrepreneurship is mainly categorised as youth, they face challenges and struggle to survive with their family and business. They might have an education loan to be settled, and at the same time, they also need capital to start and expand their business. Therefore, the government needs to support the youth financially to get more young generations involved in agriculture (Abdullah et al., 2012; Nor et al., 2015).

Tahir et al. (2020) studied the insect and pest populations in MMT cultivation in an open area under a rain shelter. The pest and insect population would be different if the researchers collected the samples under a fully closed rain house shelter or netting cover since the net prevent the insect's penetration (Kuesel et al., 2019; Soti

et al., 2020). The management of pest control and pesticide application under both conditions is different. Further investigation can be conducted as MMT yield responds differently to seasonal variation (Ong & Khandaker, 2021). The rock melon planting in the dried season has a better production than in the wet season since it is less vulnerable to disease and environmental changes. Adnan et al. (2021) justified that natural pollination in melon cultivation plays a significant role in crop production for an open area of rock melon planting in tropical regions. The economic value of melon is estimated to be RM 72,048.00 for the Gunung Tebu Forest Reserves in Besut, Terengganu, or 95 percent of the total melon production of RM 75,840.00.

Fig. 4 represents network visualisation based on the text data. The result identified six different clusters of the MMT research discipline from multiple databases shown in different circle colours. The themes output was assigned as crop performance cluster, agriculture and food industry cluster, probiotic drink cluster, product texture cluster, product preservation cluster and biochemistry properties cluster. The discipline categories in Fig. 4 and Table 3 are slightly different because Table 3 was grouped based on the nature of the papers. In contrast, Fig. 4 was generated automatically using the VOSviewer software algorithm based on the terms in the title and abstract section. Fig. 4 could be used as alternative evidence to illustrate visually on knowledge domain of MMT research as listed in Table 3. The visualisation map generated represents the sub-topic of the specific research area and its position within the assigned domain (Ahmi, 2021). Biochemistry properties clusters include terms such as total flavonoid contents, polyphenol and anti-inflammatory activity. The crop performance cluster is characterised by quality, growth, dry season and parameter terms. Clusters associated with product development include the probiotic drink cluster (day, acceptability), the product texture cluster (hardness, cooky, and colour analysis), and the product preservation cluster (heat pretreatment, seed, antioxidant properties). All of the clusters generated are linked to the agriculture and food industry cluster. The product texture, probiotic drink, and product preservation clusters are among the vital agriculture downstream industries. One of the critical indicators for crop performance cluster is water productivity of melon. Water productivity indicates the amount of crop yield per unit of water used. It is estimated that the water productivity of melon is categorised as high (around 7.93 kg/m<sup>3</sup>), which demonstrates that melon could be further improved to produce higher crop water productivity (Jusoh et al., 2020; Rashidi & Gholami, 2008).

To the best of our knowledge, this is the first synthesis analysis conducted on MMT research in Malaysia. This study provides valuable information on the research overview of MMT. One of the study's strengths was incorporating a computer tool into the charting data to generate a more accurate result interpretation. The information gathered in this study may aid scholars in deciding on a research area of interest. Indirectly, it may assist in shedding light on hitherto unexplored study areas to prepare research proposals locally or internationally. Several other research areas remain untapped and should be explored, including irrigation practices, climatic change, computer simulation, farmer perception, and model development. However, this scoping review has some limitations that should be considered. The authors tried to analyse the data obtained as comprehensively as possible. Some articles might not be retrieved, and some might be hidden due to the keyword selection and redundancy of multidisciplinary knowledge. This study focused on scholarly peer-review articles; therefore, grey literature was excluded. Quality assessment or critical appraisal evaluation of individual studies was not considered in this publication since the authors tried to add the number of articles to be synthesised as much as possible.



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