



# Yield and Fruit Quality of Four Melon Varieties Cultivated Using the Deep Flow Technique Hydroponic System

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**Abstract:** This study compares the yield, fruit quality, and economic return of four melon varieties: Galia, Asahi, Khaitongkham, and Baramée. The experiment was conducted in a closed greenhouse using the Deep Flow Technique (DFT) hydroponic system in Sa Kaeo Province, Thailand. The experiment used a Completely Randomized Design (CRD) with four treatments, each replicated five times with 10 plants per replication. Data were collected from five plants per replication for analysis. The results showed that Baramée produced the highest average fruit weight ( $1.9875 \pm 0.1021$  kg), which was statistically significant ( $p < 0.05$ ) compared to the other three varieties: Galia ( $1.6975 \pm 0.0386$  kg), Asahi ( $1.6225 \pm 0.0866$  kg), and Khaitongkham ( $1.5400 \pm 0.1414$  kg). However, the Galia exhibited the highest total soluble solids content, measuring  $15.5500 \pm 0.0577$  °Brix, which was significantly higher ( $p < 0.05$ ) than Baramée ( $14.9500 \pm 0.5562$  °Brix), Asahi ( $14.8000 \pm 0.0817$  °Brix), and Khaitongkham ( $14.1500 \pm 0.0577$  °Brix). Cultivating melons in a closed greenhouse system with a DFT hydroponic system effectively reduced pest and disease infestations. This resulted in high-quality fruit flesh and rind with no spoilage or cracking observed. The survival rate of all four melon varieties exceeded 97%, with no statistically significant differences. Furthermore, the Baramée variety provided the highest economic return, generating a profit of 28,750.63 THB per production cycle. These findings can be applied to improve the cultivation of melons or other crops, enhancing production efficiency and ensuring sustainable income for farmers.

**Keywords:** Melon; DFT hydroponic; yield; fruit quality

## 1. Introduction

One of the major challenges in crop cultivation is the improper use of chemicals, which leads to pesticide residues exceeding safety standards. This poses health risks to farmers and consumers and is a common issue in soil-based crop cultivation. These problems stem from soil degradation, water scarcity, climate variability, and the prevalence of plant diseases and pests often associated with traditional soil-based agricultural systems. Consequently, chemical dependency has become a common solution to address these issues [1].

Hydroponic cultivation presents an excellent alternative as it enables better control over growing conditions and reduces the risks of plant diseases and pests commonly found in soil-based cultivation systems.

Hydroponic cultivation, which involves growing plants without soil and using nutrient solutions, has gained popularity in many countries. This method allows precise control over the growing environment, enabling plants to achieve optimal growth while reducing the use of harmful chemicals and pesticides that pose risks to consumers. One popular technique for hydroponic melon cultivation in Thailand is the Deep Flow Technique (DFT). This method involves submerging plant roots in a continuously circulating nutrient solution with a depth of more than 15-20 centimeters using non-sloped planting troughs. A key advantage of this technique is the continuous supply of oxygen and nutrients to the plant roots, which promotes rapid growth and high-quality yields. The DFT method effectively addresses this issue in Thailand's hot climate, where plants often suffer from water scarcity during certain periods [2]. Additionally, hydroponic cultivation enables year-round planting. However, Thailand's hot and humid climate can lead to inconsistent yields, and off-season production remains challenging, particularly during the dry season. To overcome these obstacles, closed or controlled environment greenhouse systems are employed. These systems regulate temperature, light, and humidity, providing optimal growing conditions. The modern societal shift towards health and food safety further highlights the benefits of hydroponic cultivation. Closed greenhouse systems significantly reduce the need for chemical pesticides, enabling farmers to produce melons in greater quantities and with higher quality [3-4]. However, hydroponic cultivation requires careful monitoring and adjustment of nutrient solutions to match the specific needs of each plant species. This is crucial because different plants have varying nutrient requirements. Nutrient solution levels must be controlled by measuring the electrical conductivity (EC) to ensure appropriate nutrient concentration and monitoring pH levels to maintain proper acidity or alkalinity. These parameters must be checked daily until the harvest to ensure high-quality yields [5].

Melon (*Cucumis melo* L.), a member of the Cucurbitaceae family, is often referred to as the "queen of cucurbits" and is a commercially significant fruit in many countries. Its popularity stems from its sweet flavor, fragrant aroma, and high beta-carotene content, which varies depending on the variety. However, issues such as inconsistent sweetness, fruit weight, and susceptibility to soil-borne pests and diseases remain challenges in melon production [6]. Melons thrive in both temperate and tropical climates and are believed to have originated in India. In Thailand, two main groups of melons are commonly cultivated. The first group, *C. melo* var. *reticulatus*, includes netted melons, also known as muskmelons, characterized by their netted rinds and flesh that can be green, greenish-yellow, or orange. Popular varieties of this group include Galia and hybrids such as Asahi and Baramée. The second group, *C. melo* var. *inodorus*, consists of smooth-skinned melons like Honeydew and hybrids like Khaitongkham. These varietal differences influence the specific environmental conditions required for optimal growth [7-8].

This study focuses on four commonly grown melon varieties in Thailand, Galia, Asahi, Khaitongkham, and Baramée, each with distinct characteristics. Galia 1346/2559 produces round melon with very thin skin, initially green but turning light orange (golden-yellow) when ripe. The rind features a fine, white netted pattern, and the inner flesh is light green. The average fruit weight ranges from 1.3 - 2.5 kg, with a high total soluble solids (TSS) content ranging from 14 - 17 °Brix [9]. Asahi is characterized by its green netted rind and crisp orange flesh, with a high total soluble solids (TSS) content ranging from 1.5 to 2.4 kg and a high total soluble solids (TSS) content ranging from 14 - 16 °Brix [10]. Khaitongkham 1328/2558: Characterized by its smooth golden skin and firm orange flesh resembling apples, this variety has an average weight ranging from 1.5 to 2.3 kg and a high total soluble solids (TSS) content ranging from 12 -15 °Brix [11]. Baramée 1344/2559 has a round shape with a netted rind. Its orange flesh is crisp, fragrant, and sweet, with a high total soluble solids (TSS) content ranging from 14 - 15 °Brix. The fruits are larger, weighing between 1.8 -2.0 kg [12]. Therefore, to address the abovementioned issues, the researcher developed the concept of comparing four melon varieties suitable for cultivation in closed greenhouse systems using the DFT hydroponic system. This

study has been conducted under uniform environmental conditions and cultivation practices to develop a model that can be applied to melon farming to maximize benefits for growers.

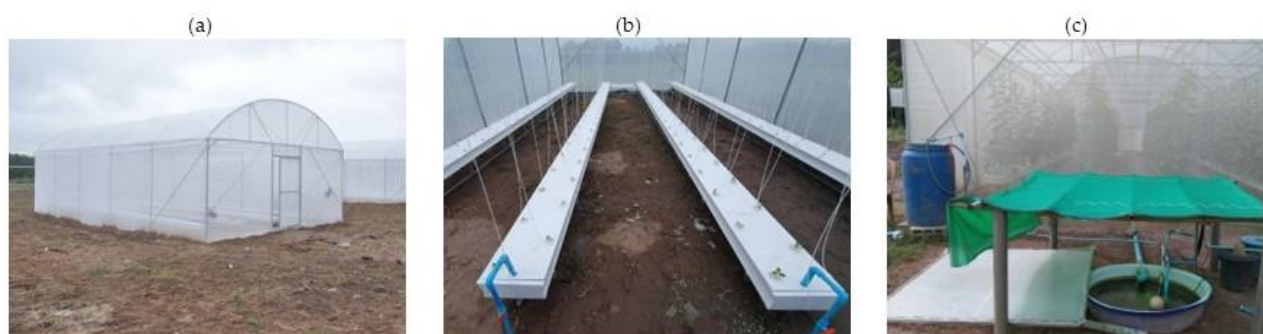
## 2. Materials and Methods

### 2.1 Experimental Design

The study on the yield and fruit quality of four melon varieties was conducted at the Agricultural Learning Center of General Prem Tinsulanonda Statesman Foundation, Non-Mak Khaeng Subdistrict, Watthana Nakhon District, Sa Kaeo Province, Thailand. The study was carried out from May to August 2024. The experiment was designed using a Completely Randomized Design (CRD), with melon varieties as the experimental treatments. The experiment consisted of five replications, each with 10 plants. Five plants were randomly selected from each replication for data analysis.

### 2.2 Preparation of the Greenhouse for Melon Cultivation Using the Deep Flow Technique (DFT) Hydroponic System

This experiment was conducted in a greenhouse measuring 6 m wide, 12 m long, and 3 m high, with a total usable area of 72 m<sup>2</sup>. The roof was covered with 150-micron plastic to shield the plants from sunlight and regulate the greenhouse's temperature. Additionally, insect-proof nets with 40 threads per inch mesh were installed along the sides to prevent pests from entering (Figure 1a). The cultivation system employed in the greenhouse was the Deep Flow Technique (DFT) hydroponic system, where plant roots are submerged in a nutrient solution at a depth of approximately 0.15 – 0.20 m. four planting rows made of aluminum were set up to accommodate the melon plants. Each planting row measured 0.45 m wide, 11 m long, and 0.25 m deep, with 50 planting holes per row. The planting holes were arranged in a staggered layout with a spacing of 0.30 m between them. The greenhouse could cultivate up to 200 melon plants (Figure 1b). Tap water was used as the primary water source for the hydroponic system in this experiment. Before use, the water was allowed to stand for 24 hours to allow for chlorine dissipation and ensure its suitability for plant growth. The water system utilized in the greenhouse was a recirculating system, where the nutrient solution from all planting rows flowed into a 500 L mixing tank. A float valve controlled the water level in the tank, and a water pump was used to circulate the solution back into the planting rows (Figure 1c). The pump also ensured uniform distribution of nutrients and enhanced oxygen levels in the solution to promote healthy root growth. This greenhouse setup was designed to optimize melon cultivation using the DFT hydroponic system, ensuring high-quality yields and providing knowledge that can be applied to improve production efficiency in future agricultural practices.



**Figure 1.** Characteristics of a melon growing greenhouse: (a) greenhouse, (b) growing trough, and (c) tank for mixing fertilizers A and B.

### 2.3 Nutrient Management and Application

The plant nutrient solution consists of two separately prepared stock solutions: Stock A and Stock B. Stock A contains Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Sulfur (S), Molybdenum

(Mo), Boron (B), Zinc (Zn), Copper (Cu), and Manganese (Mn), while Stock B contains Calcium (Ca) and Iron (Fe). To prepare this solution, 1 kg of the stock is dissolved in 10 L of clean water, resulting in a solution concentration of 100 grams per liter. The mixture is stirred thoroughly until fully dissolved, then sealed and stored in a shaded area. When the solutions are ready, equal amounts of Stock A and B are measured and added to the mixing tank. Stock A is added first and stirred thoroughly to ensure even blending. Stock B is added and mixed into the solution until a uniform mixture is achieved. Adjusting the concentrations of Stock A and Stock B is crucial in managing the nutrient balance for melons in the hydroponic system. This study uses a 500 L mixing tank to prepare the nutrient solution. An Electrical Conductivity (EC) meter measures the total nutrient concentration in the solution. Once the nutrient solution reaches the appropriate EC level, the pH is adjusted by adding nitric acid. This process ensures that both EC and pH levels are maintained within the optimal range, as indicated in Table 1. The adjustments are carried out daily at 2 specific times: 6:00 AM and 6:00 PM, ensuring consistent nutrient availability for the plants. In addition to nutrient absorption through the roots, three types of nutrients are applied via foliar spraying according to a specific schedule to enhance plant growth and fruit quality. Calcium Boron (Ca-B) is sprayed first on days 23, 30, and 35. Following this, 2 nutrients, including Calcium Boron (Ca-B) and Potassium Sulfate ( $K_2SO_4$ ), are applied together on days 38, 45, 52, 59, 66, and 73. Afterward, only Potassium Nitrate ( $KNO_3$ ) is sprayed on days 42, 49, and 56. In the final stages, Potassium Sulfate ( $K_2SO_4$ ) is applied on days 69, 71, 74, 76, 80, 82, and 84. From day 86 onward, all nutrient applications are discontinued to prepare the plants for the harvest phase, ensuring optimal fruit quality and readiness for collection.

**Table 1.** Control EC and pH levels in each stage of melon cultivation using the deep flow technique (DFT) hydroponic system.

Day	Planting Stages	EC (mS/cm)	pH
1 -13	Seedling Cultivation	0.5 – 0.8	5.6 – 6.5
14 - 35	Plant Development	1.0 – 1.3	5.6 – 6.5
36 - 42	Pollination	1.5 – 2.0	5.6 – 6.5
43 – 84	Fruit Development	2.0 – 2.3	5.6 – 6.5
85- 90	Harvest Preparation	Refrain from AB fertilizer	
91	Harvesting		

#### 2.4 Methods of Melon Cultivation in a Hydroponic System

In melon cultivation in Figure 2, the seed germination process begins by soaking the melon seeds in warm water at 40– 45°C for at least 45 minutes. This step helps to activate the seeds and initiate the germination process. After soaking, the seeds are placed on a clean, damp cloth, such as muslin, and sprinkled with water to keep them moist. The cloth is then covered to maintain humidity, and the seeds are incubated at room temperature for one night (24 hours). The seeds begin to sprout during this incubation period, and small roots emerge. Once the seeds have sprouted, they are carefully transferred to a germination sponge, a hydroponic growing medium. The root tip of each seed is gently inserted into the germination sponge at a depth of approximately one-third of the cube's thickness. This ensures proper positioning and allows the roots to absorb nutrients and water effectively. The germination sponge cubes containing the seeds are then placed in seedling trays. These trays are kept moist by immersing them in water or a nutrient solution prepared using Fertilizer A and B, following the recommended EC (Electrical Conductivity) and pH levels specified in Table 1. After 14 days, the seedlings will have developed 2 - 3 cotyledon leaves. The seedlings are ready to be transplanted into the planting troughs at this stage. Carefully remove the seedlings from the trays, not damaging the roots. Place each seedling into the hydroponic planting pot in the prepared planting troughs. The nutrient levels for this stage should follow the specifications outlined in Table 1.

During the growth phase, it is essential to prune the lateral shoots (branches) emerging at nodes 1–8 to encourage optimal growth of the main stem. The nodes 9–12 are ideal for pollination and fruit setting, as they provide the most suitable conditions for fruit development. Throughout the growth period, regular care must be taken to train the plant to climb along support strings. This ensures the plants grow upright, remain stable, and develop strong stems, facilitating efficient nutrient uptake and maximizing yield potential. After transplanting, during days 36–42, the melons enter the pollination stage. Pollination should be conducted between 6:00 AM and 10:00 AM, the optimal time for adequate pollination. Following pollination, the plants are monitored for fruit set. Once the fruits reach the size of a fist, selection begins to retain only one fruit per plant. This ensures that the plant's resources are concentrated on producing a single high-quality fruit. To maintain the fruit's shape and support its growth, a string is tied around the fruit's peduncle to keep the branch parallel to the ground. At this stage, pruning is carried out by removing the apical bud at the 26th leaf. This halts further vegetative growth and redirects the plant's nutrients toward fruit development. As the melons approach the harvest stage, the plants are watered with plain water for at least 5 days before harvest. This practice reduces nutrient solution residues in the fruits, ensuring safety and quality. Harvesting typically begins around day 91, though it may occur earlier based on observations of fruit characteristics such as color, netting, fruit shape, internal appearance, and fruit skin. This careful and structured process ensures that the melons are of high quality, both in terms of appearance and flavor, meeting the desired standards for market or consumption.



**Figure 2.** Melon cultivation: (a) seed germination, (b) seedling nursery, (c) transferring seedlings to planting channels, (d) wrapping twine around the plant for support, (e) caring for plants and pruning side branches, (f) pollination, (g) fruit selection and (h) harvesting the produce

### 2.5 Analysis of Total Soluble Solids, Fruit Weight, and External and Internal Characteristics

The quality of the melons is analyzed through measurements of fresh fruit weight, total soluble solids (TSS), and observations of external and internal characteristics. The external characteristics included fruit shape, skin color, and fruit skin netting, while the internal characteristics included internal appearance. The weight of the fresh fruit is measured individually using a digital scale. Each fruit is weighed, and the weight is recorded in kilograms (kg) to determine the average weight for the sample. Next, the fruit's external and internal characteristics are observed, recorded, and evaluated using the RHS color chart, ensuring consistent and accurate grading. This process allows for a thorough assessment of the melons' physical properties. Finally, the total soluble solids (TSS) content is measured to assess the sweetness of the fruit. The process

begins by cutting the fruit and extracting the juice using a clean muslin cloth. A small amount of the extracted juice is then dropped onto the prism of a Hand Refractometer. The prism is covered with a light-shielding plate to distribute the juice evenly. The TSS value is read through the refractometer's eyepiece in a well-lit area and is expressed in degrees Brix (°Brix).

## 2.6 Analysis of Survival Percentage for Four Melon Varieties

The survival percentage for melon cultivation was analyzed to evaluate the resilience and adaptability of the four varieties. The experiment involved five replications, each with 10 plants, for 50 plants per variety. Data on the survival of the melon plants from each variety were collected and used to calculate the survival percentage. The survival percentage was determined using the formula by Peeracha et al. [13].

$$\text{Survival Rate (\%)} = \frac{\text{Number of surviving} \times 100}{\text{Total number of plants}}$$

This calculation provides the percentage of plants that survived the experimental conditions. The results allow for a comparative analysis of the varieties' performance and suitability for cultivation in the specified hydroponic system. The survival is expressed as a percentage, offering insights into the success rate of the cultivation process.

## 2.7 Return on Investment for Cultivating Four Melon Varieties

The returns from cultivating 4 melon varieties per production cycle were calculated under the same environmental conditions. Each production cycle accommodates 200 plants, with an average production cost of 6,130 THB per cycle. This cost includes seeds, A and B fertilizer, germination sponge, potassium sulfate, calcium boron, trichoderma, wood vinegar, and Ridomil. However, it does not include the costs of constructing the greenhouse, hydroponic system setup, water, electricity, or labor. The analysis involves calculating the survival rate, average fruit weight, and market price. The selling price for melons is set at 90 THB per kg, which is used to compute the total revenue and profit per production cycle.

### 2.7.1 Survival Rate per Production Cycle

The survival rate for each variety is calculated to determine the number of surviving plants per production cycle using the formula:

$$\text{Number of surviving plants per cycle (\%)} = \frac{\text{Survival rate percentage} \times 200}{100}$$

### 2.7.2 Revenue Calculation

The total revenue for each variety is determined by multiplying the number of surviving plants, the average fruit weight, and the selling price:

$$\text{Revenue per greenhouse} = \text{Number of surviving plants per cycle} \times \text{Average fruit weight (kg)} \times 90 \text{ THB}$$

### 2.7.3 Profit Calculation

The profit for each production cycle is calculated by subtracting the production cost from the total revenue:

$$\text{Profit per production cycle} = \text{Revenue per greenhouse} - \text{Production cost (6,130 THB)}$$

## 2.8 Data Analysis

The analysis of recorded data included growth performance, survival rates, fruit weight (kg per fruit), and total soluble solids (TSS) to evaluate differences among the four melon varieties. The process began with an Analysis of Variance (ANOVA) to assess the variability within and between groups. This step determined

whether statistically significant differences existed among the variety for each measured parameter. If significant differences were found, Duncan's New Multiple Range Test (DMRT) was used to compare the means and identify which varieties differed significantly. This test was performed with 95% confidence to ensure reliable results. The entire analysis was carried out using statistical software to enhance the accuracy and efficiency of the calculations. This approach provided comprehensive insights into the performance and quality of the melon varieties under the given experimental conditions.

### 3. Results and Discussion

#### 3.1 Analysis of Fruit Weight

The analysis of fruit weight showed that the Baramée produced the heaviest fruits, averaging  $1.9875 \pm 0.1021$  kg, significantly different from the other varieties ( $p < 0.05$ ). When comparing the 3 varieties, Galia, Asahi, and Khaitongkham, Their average fruit weights were  $1.6975 \pm 0.0386$ ,  $1.6225 \pm 0.0866$ , and  $1.5400 \pm 0.1414$  kg, respectively. These findings highlight that the melons' growth and fruit weight varied based on each variety's unique genetic traits. This finding aligns with Atikah and Alvianah [14], who stated that genetic factors determine each melon variety's unique characteristics and growth potential. In general, the fruit size of all melon varieties typically has a diameter of approximately 11–17 cm and a weight ranging between 1.2–2.7 kg [9][15]. Moreover, the growing environment also impacts the fruit weight of each melon variety, even when cultivated under the same conditions. Therefore, adjusting the nutrient levels and environmental factors to suit the specific requirements of the melon variety being grown is essential. This research found that the Baramée was the most suitable for achieving the highest fruit weight under the conditions and methods employed. In addition to standard nutrient applications (A and B), foliar fertilization significantly enhanced fruit yield and quality. Three key nutrients were applied as foliar sprays. The first nutrient is Calcium Boron (Ca-B). Calcium strengthens cell walls, resulting in firmer and crisper fruit texture. Meanwhile, Boron facilitates calcium absorption by the roots, enhances photosynthesis, and promotes pollen tube elongation. A boron deficiency can lead to abnormal pollen tube development, significantly reducing the success rate of pollination [16]. The second nutrient is Potassium Nitrate (13-0-46), which enhances fruit size and weight by stimulating the activity of enzymes in protein synthesis and carbohydrate metabolism [17]. The third nutrient is Potassium Sulfate (0-0-50), which enhances plant growth, yield, and fruit quality. This improvement is attributed to the sulfur content in the fertilizer. Sulfur is a critical component of coenzymes such as thiamine pyrophosphate, which metabolize plant carbohydrates and proteins. Additionally, sulfur plays a vital role in cell division, promoting the growth of plant shoots and aiding in chlorophyll synthesis [18]. Therefore, to achieve high-quality yields, paying close attention to and carefully managing every stage of the melon cultivation process is essential. Each step, from nutrient management to environmental control and foliar fertilization, plays a critical role in ensuring the production of melons that meet desired standards in both quality and yield.

#### 3.2 Total Soluble Solid Content

The analysis of the total soluble solid (TSS) content revealed that the Galia had the highest TSS value, significantly different from the other three varieties ( $p < 0.05$ ). The average TSS values were as follows: Galia ( $15.5500 \pm 0.0577$  °Brix), Baramée ( $14.9500 \pm 0.5562$  °Brix), Asahi ( $14.8000 \pm 0.0817$  °Brix), and Khaitongkham ( $14.1500 \pm 0.0577$  °Brix) (Table 2). However, the TSS content of all melon varieties grown using the Deep Flow Technique (DFT) hydroponic system was found to exceed the agricultural product standards set by the National Bureau of Agricultural Commodity and Food Standards (ACFS), Ministry of Agriculture and Cooperatives, which specifies a minimum of 12 °Brix [19]. For all melon varieties, the TSS standard ranges between 12 and 14 °Brix [20]. Also, soilless cultivation enables precise control of the root zone environment,

allowing plants to absorb nutrients efficiently. This contributes to improved yield and quality of melons, resulting in thicker flesh and higher total soluble solids that meet the quality standards for melon production [6].

**Table 2.** Weight and total soluble solids (TSS) of four cultivated varieties, including Galia, Asahi, Khaitongkham, and Baramée, cultivated using the deep flow technique (DFT) hydroponic system

Varieties	Weight (kg)	TSS (°Brix)
Galia 1346/2559	1.6975 ± 0.0386 <sup>bc</sup>	15.5500 ± 0.0577 <sup>a</sup>
Asahi	1.6225 ± 0.0866 <sup>bcd</sup>	14.8000 ± 0.0817 <sup>b</sup>
Khaitongkham 1328/2558	1.5400 ± 0.1414 <sup>cd</sup>	14.1500 ± 0.0577 <sup>c</sup>
Baramée 1344/2559	1.9875 ± 0.1021 <sup>a</sup>	14.9500 ± 0.5562 <sup>b</sup>
F-test	**	**
% CV	10.81	3.72

\*\* Significant difference at  $P < 0.05$ ,

<sup>a,b,c,d</sup> Statistically significant differences at 95% ( $p < 0.05$ ) were determined using Duncan's new multiple range test (DMRT)

### 3.3 Fruit Shape, Rind Color, and Flesh Color of Four Melon varieties

The research revealed that the fruits of the Galia, Asahi, Khaitongkham, and Baramée shared a circular shape but differed significantly in their rind and flesh characteristics. Galia had a golden yellow rind, clear white netting, and light green-white flesh. Asahi featured a green rind with distinct white netting and orange flesh, while Khaitongkham had a golden smooth rind without netting and golden yellow flesh. The Baramée displayed a green rind with clear white netting and orange flesh (Table 3 and Figure 3). Research showed no evidence of pest or disease infestation during harvest, as growing melons in closed greenhouses effectively minimize the risk of pest damage. Moreover, advancements in modern genetic technology have led to the development of melon varieties with diverse characteristics, such as fruit type, peel and flesh color, flavor, and disease resistance [21]. Additionally, the differences and quality of each melon variety play a crucial role in consumer preferences and market demands. Notably, a well-formed netted rind is a key indicator of ripeness and quality, significantly influencing consumers' purchasing decisions [22].

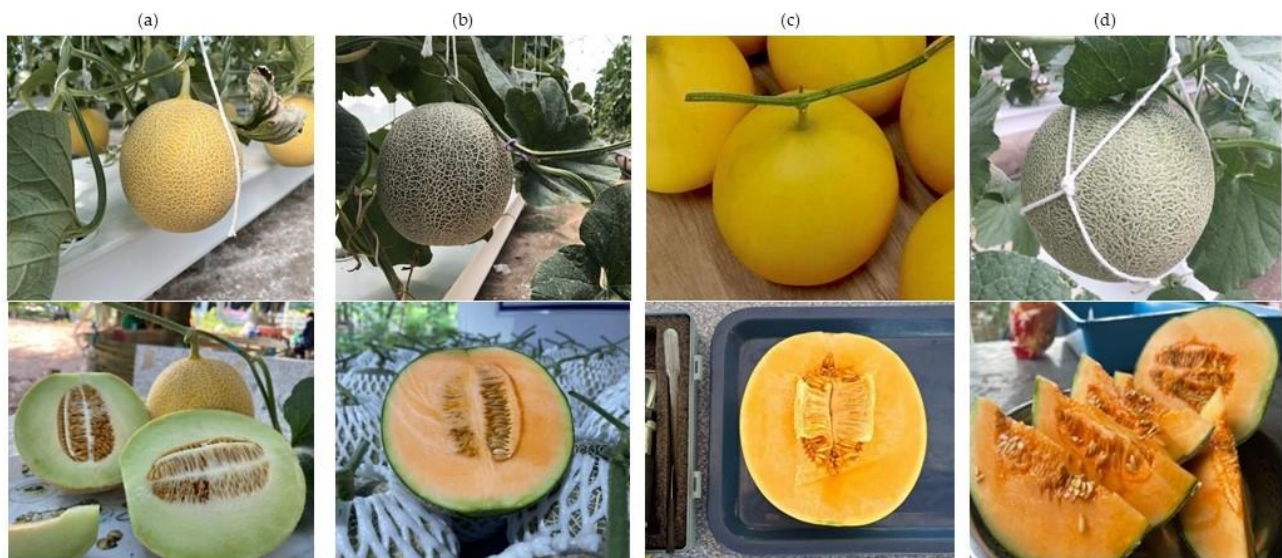
**Table 3.** Fruit shape, internal appearance, fruit skin color (by RHS color chart), and fruit skin net of four cultivated, including Galia, Asahi, Khaitongkham, and Baramée.

Varieties	Fruit shape	Internal Appearance	Fruit skin color	Fruit skin net
Galia 1346/2559	Circular	Green to white	Light orange	White net
Asahi	Circular	Orange	Green	White net
Khaitongkham 1328/2558	Circular	Gold	Gold	Non-net
Baramée 1344/2559	Circular	Orange	Orange	White net

### 3.4 Survival of Melons

The survival of melon plants within the greenhouse from planting to harvest was assessed across five replications, with each replication consisting of 10 plants. The results showed that the Asahi had the highest survival rate at 97.75%, followed by the Galia and Baramée, which both had a survival rate of 97.50%. The variety with the lowest survival rate was Khaitongkham, at 97.25%. However, statistical analysis indicated no significant differences in survival among the four varieties ( $p > 0.05$ ) (Table 4). The primary causes of plant loss were powdery mildew (*Oidium* sp.) and downy mildew (*Pseudoperonospora cubensis*), which affected plants during growth. Powdery mildew, commonly spread by wind, is often caused by overcrowded planting, poor air circulation, and insufficient light exposure. Early symptoms appear as light yellow spots on various parts of the plant. These spots grow larger and are covered with white, powder-like fungal spores, eventually

turning the leaves yellow-brown, brittle, and dry. Downy mildew primarily affects leaves, beginning as light yellow spots that gradually enlarge into brown lesions with angular shapes bordered by veins. The underside of the leaf corresponding to these lesions often exhibits fungal growth. Severe infections cause leaves to dry, with edges curling and eventually falling off, leading to vine death. To mitigate these issues, infected plants were promptly removed to prevent fungal spread, and weekly treatments with Trichoderma, wood vinegar, and ridomil were applied to control pests and diseases. This study underscores the importance of selecting melon varieties that are suited to local environmental conditions and resistant to diseases. These factors ensure high-quality yields and optimal production [23] [15]. Effective cultivation practices, including disease management and appropriate environmental adjustments, are necessary to achieve consistent survival rates and maintain the quality of melon production.



**Figure 3.** External and internal characteristics of four cultivated varieties: (a) Galia 1346/2559, (b) Asahi, (c) Khaitongkham1328/2558, and (d) Baramée 1344/2559

### 3.5 Comparison of Profits from Cultivating Four Melon Varieties

The comparison of profits generated from cultivating four melon varieties, including Baramée, Galia, Asahi, and Khaitongkham, under identical environmental conditions, reveals significant differences in economic returns. Each production cycle in a single greenhouse accommodates 200 plants, with an average production cost of 6,130 THB per cycle. Melons were sold at a fixed price of 90 THB per kg. The experiment results revealed that the Baramée achieved the highest profit due to its superior fruit weight and yield. The profits for the other varieties, in descending order, were Galia, Asahi, and Khaitongkham, with respective profits of 28,750.63, 23,661.13, 22,417.89, and 20,827.70 THB per production cycle (Table 4). These results suggest that, among the four varieties, Baramée is the most economically viable option under the specified conditions. However, the choice of variety for commercial production should also consider local environmental factors, disease resistance, and market preferences to ensure maximum profitability and sustainable melon farming.

**Table 4.** Return on investment for cultivating four melon varieties per production cycle per greenhouse

Varieties	% Survival	Survival/ Greenhouse (plant)	Weight (kg)	Selling price (THB)	Profit (THB)
Galia 1346/2559	97.50 ± 5.0000	195.00	1.6975	29,791.13	23,661.13
Asahi	97.75 ± 2.6300	195.50	1.6225	28,547.89	22,417.89
Khaitongkham 1328/2558	97.25 ± 3.2016	194.50	1.5400	26,957.70	20,827.70
Baramee 1344/2559	97.50 ± 5.0000	195.00	1.9875	34880.63	28,750.63
F-test	ns				
% CV	3.76				

ns = not Significant difference, Statistically significant differences at the 95% ( $p < 0.05$ ) were determined using Duncan's new multiple range test (DMRT)

#### 4. Conclusions

This study focused on four melon varieties' growth performance and quality, including Galia, Asahi, Khaitongkham, and Baramee. They were grown in a closed greenhouse using the Deep Flow Technique (DFT) hydroponic system. The results demonstrated that all four varieties thrived and produced high-quality yields. The Baramee had the highest average fruit weight, measuring  $1.9875 \pm 0.1021$  kg, with statistically significant differences from other varieties ( $p < 0.05$ ). Meanwhile, the Galia exhibited the highest total soluble solids (TSS) at  $15.5500 \pm 0.0577$  °Brix, also with statistically significant differences ( $p < 0.05$ ). All four varieties displayed excellent rind and flesh characteristics, with no spoilage, pest damage, or fruit cracking, resulting in a high survival percentage. However, minor losses during the growth phase were attributed to powdery mildew (*Oidium* sp.) and downy mildew (*Pseudoperonospora cubensis*). The findings indicate that cultivating the Baramee provides the highest economic return, generating 28,750.63 THB per production cycle. This research offers practical guidance for farmers to adapt or apply hydroponic melon cultivation techniques to other crops. Farmers can select varieties based on production goals, prioritizing higher yields or superior taste quality. Additionally, greenhouse management techniques, including environmental control and disease prevention, can be implemented to improve plant survival percentage. The findings can also support strategic market planning to maximize revenue from product sales. Furthermore, farmers may diversify their production by cultivating other crops using the hydroponic system, increasing income streams and reducing risks associated with market fluctuations or environmental challenges. This aligns with modern agricultural practices that emphasize value addition and sustainable development.

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