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Analysis of Consumer Behavior Towards post-harvest Operations of Fruit and Vegetable Crops

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Abstract

The research aims to analyze consumer behavior towards post-harvest processes for fruit and vegetable crops. To achieve the research objectives, a questionnaire consisting of three sections was used. The first section included personal data of the sample (gender, age, educational attainment, place of residence, marital status, and income level). The second section contained various questions about consumer behavior, while the third section included questions about post-harvest processes for fruit and vegetable crops. The validity of the instrument was confirmed using expert judgment, and its reliability was confirmed using Cronbach's alpha coefficient, which yielded a very high overall reliability value of (0.88). The data were analyzed using SAS statistical software. The research concluded that Iraqi consumers possess a high level of awareness regarding post-harvest processes. They are concerned about the storage, transportation, and packaging of fruits and vegetables, and are apprehensive about the health implications of post-harvest treatments such as processing and the use of chemicals. The research recommends the necessity of selecting packaging with a standardized label that clearly indicates the harvest date, country of origin, transportation conditions, optimal storage temperatures, and confirmation that the product is free from chemical treatment or preservatives. It also recommends providing safe alternatives to post-harvest treatments (non-heating and low in additives) and disseminating balanced scientific awareness about their safety, while addressing consumer health concerns.

Keywords: Consumer behavior, post-harvest operations, fruit and vegetable crops.

Introduction

Post-harvest operations are considered one of the important links in the value chain of agricultural products of all kinds, and this importance increases in horticultural crops such as vegetables and fruits, due to the clear positive or negative effects that result from the good or bad application of post-harvest operations on these products. These are the processes applied to agricultural products, from determining the harvest date to offering them for sale and consumption. They thus encompass the range of agricultural practices following harvesting in the field, as well as the processes involved in marketing, such as refrigeration, storage, packaging, and transportation, Therefore, the post-harvest transactions are predominantly economic and commercial in nature, whether in terms of the individuals and institutions involved, the expected outcomes and objectives, or the benefits for farmers, sorting center owners, transport operators, wholesalers, retailers, and consumers. This research aims to identify and analyze consumer behavior regarding post-harvest processes for fruits and vegetables.

Section One - Research Methodology

Research problem: The research problem can be summarized in the question: What is consumer behavior towards post-harvest processes for fruit and vegetable crops?

The importance of research: The importance of this research lies in the following:

1. Understanding consumer behavior regarding post-harvest processes for fruit and vegetable crops.
2. Understanding post-harvest processes for fruit and vegetable crops.

Research objectives: The research aims to highlight the impact of post-harvest operations for fruit and vegetable crops on the behavior of the Iraqi consumer, to identify the most important behavioral responses of consumers towards these operations, and to present some conclusions and suggestions for evaluating the behaviors of the Iraqi consumer and raising his awareness towards these operations due to their significant impact on fruit and vegetable crops.

Research hypothesis: Consumer behavior is influenced by post-harvest processes for fruit and vegetable crops.

MATERIALS & METHODS

The aim of this research is to analyze consumer behavior towards post-harvest processes for fruit and vegetable crops. Therefore, the instrument used was a survey/questionnaire. The questionnaire was developed and distributed to a sample of (400) Iraqi consumers in Baghdad during the period from January to December 2023. The reliability and validity of the study instrument were confirmed using Cronbach's alpha coefficient, and the reliability and validity ratio was 0.88.

Table (1): Reliability and validity coefficient for consumer behavior according to the questionnaire form

Reliability and validity (relative importance)	Axis
0.88	Consumer behaviour

Data analysis: In this study, descriptive statistical analysis was used to analyze demographic information and consumer responses regarding post-harvest processes for fruit and vegetable crops. The Statistical Analysis System (SAS) software (2012) was used to analyze the data and examine the relationships required by the study objectives for the independent factors and items within the consumer behavior axis covered by the questionnaire .**(Analysis of consumer behavior towards post-harvest operations of fruit and vegetable crops),** The significant differences between the averages and for each scale were compared using the Least Significant Difference (LSD) test and the t-test and the F-test. The arithmetic mean and standard deviation for each item were calculated by multiplying the numbers for each answer by the score of the answer, which was determined according to importance (Agree = 3, Neutral = 2, Disagree = 1), and then dividing by (400), which represented the total of the samples.

Section Two – Theoretical Framework

The concept of consumer behaviour: Consumer behavior is the conduct of a consumer when they seek, purchase, use, evaluate, and dispose of goods and services (after use) that they expect to satisfy their needs (Issa, 2003: 17; Al-Heali, 2022: 823). It is the behavior exhibited by the consumer in seeking to purchase or use products, ideas, or experiences that they expect will satisfy their desires and meet their needs, according to their available purchasing power (Obaidat, 2004). It is also defined as the process associated with an individual or group of individuals selecting, purchasing, using, and disposing of a product or service, including the decision-making process that precedes and determines these actions (Al-Sahn, & Al-Sayed, 2001), (Majlakh & Walid, 2018).

Factors influencing consumer behaviour: There are a number of factors that affect consumer behavior, namely: (Kotler & Armstrong, 2008), (Al-Hijazi, 2005), (Ben Tafat, 2008), (Abu Jalil et al., 2012), (Kotler & Dubois, 2000), (Catherine, 2006).

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1. Cultural Factors: Cultural factors are among the main determinants of consumer purchasing behavior and include the following:
a. Culture: This is the set of values, beliefs, perceptions, preferences, and behaviors that a consumer possesses, inherited from their family or learned from society, and which influence their purchasing behavior.
b. Subculture: This includes nationalities, religions, ethnic groups, and geographic regions that influence consumer purchasing behavior.
c. Social Class: There are different social classes, each with characteristics shared by its members, which is reflected in the similarity of their purchasing behavior.
2. Social Factors: These include:
a. Reference Groups: These consist of two or more individuals who interact and exchange ideas to achieve individual or shared goals. They exert a direct or indirect influence on consumer purchasing behavior, and consumers use these groups to compare their own behavior or characteristics with those of the group members.
b. The Family: This is the primary and most frequent group with which the consumer interacts. The family's members, based on their knowledge of various goods and services, influence their perceptions and beliefs.
c. Opinion Leaders: These are individuals or groups within a reference group who influence others due to their skills, knowledge, personality, or other qualities that enable them to persuade others of their opinions.
d. Role and Status: These are the roles an individual plays in their life and the positions they hold, which significantly impact their purchasing behavior to align with the nature of those roles.
3. Personal Factors: These include age, gender, occupation, economic circumstances, and personal lifestyle.
4. Psychological Factors: These comprise a set of factors related to consumer motivation and the needs that drive consumers toward specific behaviors to satisfy their desires and needs. These include:
a. Motives: These are the driving forces within individuals that propel them to behave in a particular direction and enable them to understand their environment and interpret information related to it. Motives are divided into rational motives, which arise when a purchase decision is made after prior study or planning (a rational purchase), and emotional motives, which arise when a purchase decision is made without prior study or planning (an emotional purchase).
b. Perception: This is the process by which an individual's mental impressions are formed when they select, receive, organize, and interpret external information to create a picture related to their surroundings. (Kotler & Dubois, 2000)
c. Learning: This refers to the interpretations of consumer behavior and actions resulting from acquired experience, information, and training.
d. Memory: This enables consumers to store and retrieve information about goods and services when needed.
E. Attitudes: These are the consumer's behavioral tendencies toward a product or service.
5. Situational Factors: Situational factors influence consumer purchasing behavior as follows:
a. Purchasing Task: This is the purchase that the buyer wishes to accomplish.
b. Physical Environment: These are factors related to decor, music, and the size of the crowd inside the store.
c. Time Influences: This is the time available to the consumer to make their purchasing decision.
d. Past Practices: These are the patterns of interaction the consumer has become accustomed to in the purchasing process.

The concept of post-harvest operations

These are the methods, tools, and equipment that can be used to reduce or stop the factors of deterioration and spoilage in fresh agricultural crops. They aim to preserve the quality of agricultural crops for as long as possible and to minimize post-harvest losses and spoilage. This is achieved by understanding the biological and environmental factors that cause quality deterioration in fresh agricultural crops, and by introducing and using appropriate post-harvest techniques that limit the activity of various deteriorating factors and the conditions conducive to their development. Determining the appropriate harvesting dates and managing the harvest can be considered among the fundamental processes affecting the success of post-harvest operations, as it is the starting point in the series of processes for preparing and processing fresh agricultural crops for marketing (Al-Ajaleen, 2005).

Post-harvest Operations for fruit and vegetable crops

Focusing on improving the appearance of fruits and vegetables after harvest makes them more desirable to consumers, regardless of price. The cost of post-harvest handling does not increase the product's price compared to the losses resulting from the deterioration of crop quality when necessary steps are not taken. Reducing losses means increased production and savings in effort and economic resources. It is estimated that 25% of post-harvest losses of vegetables in developing countries are due to poor handling practices and damage caused by insect infestations and diseases. Despite advancements in agricultural techniques that have led to increased production, vegetable handling methods remain inadequate, resulting in significant losses at various stages of the marketing process. Reducing or eliminating these losses benefits both producers and consumers. Achieving and maintaining quality is an integrated system that involves controlling each stage, as each stage is interconnected with the previous one, forming a single chain encompassing production, harvesting, handling, transportation, and marketing. (Liza, 2002)
The post-harvest steps can be explained as follows:
First: Harvesting Fruits and Vegetables: This involves gathering the crops from the field at the ripening stage with minimal losses, at the lowest cost, and as quickly as possible, using manual harvesting methods for most fruits and vegetables. It is important to avoid exposing crops to sunlight during and after harvesting, as crops left in the sun will absorb heat approximately 4-6 degrees Celsius higher than the air temperature (Thompson et al., 2001). Some of the methods used in harvesting crops include:

1- **Manual Harvesting** is considered one of the best methods because the human hand can determine the appropriate degree of ripeness, thus ensure correct grading and harvesting with minimal damage. Furthermore, the harvest quantity can be increased by increasing the workforce due to its lower cost. Some equipment and machinery are used in conjunction with manual harvesting, such as conveyor belts for lettuce and melons, and platforms and ladders for some crops like dates, citrus fruits, bananas, and olives.
2- **Mechanical harvesting** is used for harvesting fruits and vegetables intended for processing or those not easily damaged by mechanical means, such as nuts, roots, and tubers. Key advantages of mechanical harvesting include speed, comfortable working conditions, and reduced labor-related problems. However, significant drawbacks include damage to perennial crops, particularly tree bark from shaking, and reduced processing and handling capacity for achieving maximum harvesting rates.

Second: Treatment: This is the process that follows harvesting to increase the crop's shelf life. This process is carried out for two main crops: potatoes and onions. For potatoes, irrigation is stopped two weeks before harvesting, and the tubers are left to dry, thus increasing their storage and transportability. For onions, the treatment process involves removing the foliage, leaving about 1 cm of the bulbs. The bulbs are then harvested and placed for 2-3 days in a shaded, well-ventilated area. This hardens the outer skin of the bulbs, preventing fungal growth and thus extending their storage life and reducing spoilage.

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Third: Washing and Cleaning: This is a very important process, especially for root vegetables such as potatoes, carrots, and beets, and for fruits that grow close to the soil surface, such as lettuce and tomatoes. Washing removes dirt and impurities, reduces the number of microorganisms, and restores the fruits' freshness.

Fourth: Disinfection: Fruit and vegetable crops are disinfected by removing any microorganisms that may be present on their surface using disinfectants that do not affect human health and do not damage the crop tissues themselves or leave any unpleasant taste. These disinfectants should be effective in killing microorganisms and should be easily spread on the fruit's surface and inexpensive, such as borax, boric acid (4-5%), or potassium permanganate. The crops should be washed thoroughly with water after using the disinfectant.

Fifth: Drying: This involves placing the crops in special dryers that force air at high speed to remove any remaining water from the crop surfaces. The air temperature inside the dryers should be between 7-12 degrees Celsius to prevent damage to the fruit.

Sixth: Sorting: This involves removing misshapen, bruised, damaged, diseased, insect-infested, or unripe produce. It is preferable for highly skilled individuals to perform the sorting; otherwise, the process will need to be repeated. One advantage of grading is ensuring uniformity in fruit size within each package, facilitating packing by allowing for the packaging of a single type or quantity of produce, and minimizing gaps in the container. Grading is divided into three categories: size, color, and weight.

Seventh: Removing Undesirable Parts: This procedure is particularly important for lettuce, celery, cabbage, and spinach. Leaves with soil adhering to them, or drooping outer leaves, are removed. This improves the appearance of the produce and reduces the spread of diseases during transport and marketing. In turnips and carrots, all leaves may be cut, leaving some as a protective layer during transport. These leaves should be removed just before the product is offered for sale. Alternatively, roots may be trimmed, as in lettuce and spinach.

Eighth: Wrapping and Packaging: Some crops are wrapped to give them an attractive appearance and to prevent the spread of infection from one infected fruit to another within the package. This wrapping process can be carried out, especially for crops destined for distant markets, using paper wraps. Waxed paper can also be used to protect the fruit from bruising and to maintain its moisture content during transport and storage.

Ninth: Waxing: This process is carried out using German wax emulsion, waterless wax, regular melted wax, or paraffin wax to coat the fruit with a thin layer no thicker than 0.03 mm. This prevents the fruit from wilting and shriveling, as the waxing process reduces moisture loss from the fruit's surface, thus preventing wilting and giving the fruit a glossy sheen, as is the case with cucumbers and tomatoes.

Tenth: Packaging: After preparing the fruits and vegetables, they are packed in special containers, whether cardboard, cork, or wooden boxes, or perforated polyethylene bags. This protects the produce from mechanical and physiological damage during transport and handling. The various packages are then collected in the shade for marketing or delivery to refrigerated warehouses. Packaging facilitates the transport of fruits and vegetables from their production areas to markets, preserves the produce during transport and handles to extend its shelf life, and maintains the cleanliness and prevents contamination. It also allows for an initial estimate of the total crop quantity by counting the number and weight of the units, and attracts consumers with attractive packaging.

Eleventh: Pre-cooling: This involves removing or eliminating field heat immediately after harvest and before any further handling. It is called pre-cooling or rapid cooling, as the temperature of fruits and vegetables is quickly reduced after harvesting or packing to remove latent heat (field and ambient temperature) until it reaches the temperature at which they will be shipped or stored. This reduces the burden on refrigeration equipment in storage rooms. Any delay in pre-cooling leads to a shorter shelf life and reduced quality. The benefits of cooling include slowing down crop respiration, thus reducing spoilage; slowing the growth of microorganisms; reducing or preventing insect reproduction or egg hatching; reducing evaporation during transport; facilitating subsequent cooling processes during shipping or in cold storage facilities; reducing transpiration, which leads to less water loss and wilting; reducing ethylene gas production, thus delaying ripening, discoloration, and deterioration of fruit quality; and reducing disease incidence.

Twelfth: Storage: Citrus fruits, apples, potatoes, and sometimes grapes are among the main products stored in refrigerated warehouses for a period ranging from 2-5 months under ideal storage conditions. There are several methods for storing fruit and vegetable crops, and the type of storage varies according to the type of crop, the method of packing, and the storage period. Paying attention to the storage process is very important to maintain the quality of the product in good condition for the longest possible period and to ensure the availability of the product in the markets for the longest possible period. Refrigerated warehouses provide products when they are scarce and store them when they are plentiful, which ensures the regulation of the price of the food product for the consumer and the producer alike, in addition to the possibility of exporting surplus products abroad and obtaining hard currency.

Thirteenth: Transportation: This is the penultimate process, moving the product from production sites to consumption points. It is carried out in two ways:

1. Regular trucks, used for transporting nearby areas and for crops affected by surrounding environmental conditions.
2. Refrigerated trucks, used for transporting long distances, especially for highly perishable crops such as tomatoes, bananas, and apples.

Fourteenth: Care and Storage of Fruits and Vegetables: The care, storage, and marketing processes for crops aim to preserve them so they reach the consumer in high quality. This is achieved by slowing down the metabolic activity in the fruit to utilize stored nutrients slowly, thus preserving its characteristics and extending its shelf life. Even after harvesting, fruits continue to respire and consume the compounds stored in their tissues, producing heat, carbon dioxide, and water vapor. Therefore, cooling agricultural crops is necessary during transportation, storage, and marketing.

Obstacles to the development of post-harvest technologies

1. Weaknesses in the capacity and efficiency of post-harvest infrastructure, the continued use of some flawed traditional methods, and a lack of attention to adopting modern technologies.
2. The absence of advanced marketing databases.
3. General weaknesses in marketing channels in terms of infrastructure, management, and information exchange.
4. Insufficient attention to maintaining, developing, and preserving existing infrastructure.
5. The lack of scientific research and development programs in post-harvest operations.
6. The absence of specialized extension services in post-harvest operations and agricultural marketing.
7. High production and marketing costs.
8. A shortage of local experts in post-harvest operations.
9. Weak cooperation and coordination among relevant public and private sector institutions and organizations in the field of post-harvest operations and marketing (Al-Ajaleen, 2005).

Methods of controlling post-harvest damage to horticultural crops: The methods for reducing post-harvest losses in horticultural crops can be summarized in the following practices (Al-Saadoun & Al-Hamdan, 2004):

1. Paying close attention to all agricultural practices to achieve high-quality fruit.
2. Determining the optimal harvest time, the appropriate stage of ripeness, and the harvesting method.
3. Establishing a specific and rigorous program that harvesters must adhere to during harvesting, preparation, and storage. This includes scheduling and documenting harvesting, handling, and storage data, including losses.

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4. Reducing the period between harvesting and refrigerated storage, fresh consumption, or processing.
5. Minimizing mechanical damage to horticultural crops during harvesting, preparation, packing, grading, transportation, and handling.
6. Selecting appropriate packaging with a good design to reduce mechanical damage and allow for product ventilation.
7. Paying close attention to fruit preparation processes, including washing, waxing, grading, sorting, and packing. 8. Implement pre-cooling methods to quickly dissipate field heat and utilize cooling during the transport or storage of horticultural crops.
8. Control temperature, relative humidity, and ventilation in storage facilities as essential means of controlling respiration rates and water loss.

3. RESULTS AND DISCUSSION

1. Demographic information

The research was conducted on a sample of consumers in the city of Baghdad, and the number of individuals in the sample was (400) people. The questionnaire was distributed to them. The following is a table that shows the characteristics of the research sample.

Table (2): Distribution of the sample according to personal information

Demographic info.	Frequency	Percentage (%)
Gender		
male	296	%74
female	104	%26
age (year)		
Under 20 years old	44	%11
25- 21	120	%30
26-30	92	%23
31-35	40	%10
36-40	36	%9
41-45	28	%7
46-50	20	%5
51-55	8	%2
56-60 سنة	8	%2
61greater than	4	%1
Academic achievement		
Preparatory	84	%21
Bachelor's	196	%49
Postgraduate Studies	120	%30
Residence		
Al-Karkh	188	%47
Al-Rusafa	128	%32
Other	84	%21
monthly income		
Good	116	%29
Average	200	%50
Poor	84	%21
marital status		
Married	180	%45
Single	176	%44
Divorced / Widowed	44	%11

We note in Table (2) the distribution of the sample members according to personal variables that...

1. Regarding the gender variable, the majority of the sample consisted of males, comprising approximately 74%, while females comprised about 26%.
2. The 21-25 age group represented the largest segment of the sample, at 30%, while the 61 and older age group was the smallest, at approximately 1%.
3. A bachelor's degree was the most common educational qualification among the sample, representing 49%, while a secondary school diploma was the least common, at approximately 21%.
4. Regarding place of residence, Al-Karkh represented the largest percentage, at 47%, while other areas accounted for the smallest percentage, at 21%.
5. The average monthly income of the sample comprised 50%, while those with low incomes constituted the smallest percentage, at 21%. 6. As for the marital status, we find that the largest percentage is that of married people, which constituted approximately 45% of the sample, while the percentage of (widower/divorced) constituted the lowest percentage, which amounted to 11%.

2.Field research findings:

Table (3): shows the frequency distributions, percentages, and standard deviations of the variable "Iraqi Consumer Behavior towards Post-Harvest Processes for Fruit and Vegetable Crops".

Sequence	Questions	Agree		Neutral		Disagree			mean	Standard deviation	Percentage of agreement	t-test
Awareness of post-harvest processes		Freq	%	freq	%	freq	%	sum freq				
1	When you buy fruits and vegetables, you pay attention to the storage process.	380	95	20	5	-	-	400	2.95	0.218	95.0	87.06
2	When you buy fruits and vegetables, you pay attention to the packaging process.	300	75	90	22.5	10	2.5	400	2.725	0.5	75.0	29.0
3	When you buy fruits and vegetables, you pay attention to the transportation process.	310	77.5	50	12.5	40	10	400	2.675	0.648	77.5	20.82
4	You worry about your health from post-harvest processes such as processing and chemicals.	230	57.5	130	32.5	40	10	400	2.475	0.671	57.5	14.15
Food quality and safety												

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5	The method of storage affects the quality and safety of fruits and vegetables.	310	77.5	70	17.5	20	5	400	2.7	0.511	72.5	27.42
6	It is preferable to buy fruits and vegetables that have the least amount of post-harvest loss.	290	72.5	100	25	10	2.5	400	2.675	0.52	70.0	25.97
7	The method of transportation affects the freshness of fruits and vegetables.	280	70	110	27.5	10	2.5	400	2.925	0.346	95.0	53.47
	Packaging											
8	It is preferable to buy fruits and vegetables that are packaged in a way that preserves their freshness, such as packaging in airtight bags.	350	87.5	50	12.5	-	-	400	2.9	0.375	92.5	48.04
9	Appearance influences your decision to buy fruits and vegetables	370	92.5	30	7.5	-	-	400	2.9	0.3	90.0	59.92
10	Hygienic packaging methods influence your decision to buy fruits and vegetables.	370	92.5	20	5	10	2.5	400	2.925	0.346	95.0	53.47
11	Opt for fruits and vegetables that are packaged in environmentally friendly, biodegradable, or recyclable containers.	360	90	40	10	-	-	400	2.775	0.524	82.5	29.55
	Price and cost											
12	The prices of fruits and vegetables stored using modern methods are high compared to other products.	380	95	10	2.5	10	2.5	400	2.775	0.57	85.0	27.18
13	I prefer to buy fruits and vegetables that are displayed in stores that care about cleanliness and modern display methods.	290	72.5	110	27.5	-	-	400	2.25	0.799	47.5	6.254
14	Post-harvest processing costs (such as transportation, storage, and packaging) affect the price of the products.	340	85	30	7.5	30	7.5	400	2.6	0.701	72.5	17.12
15	I prefer supporting local products even if they are slightly more expensive.	290	72.5	110	27.5	-	-	400	2.725	0.548	77.5	26.46
	Trust and information											
16	I give importance to the information written on the product label (picking date, country of origin, storage method).	310	77.5	70	17.5	20	5	400	2.15	0.854	45.0	3.513
17	I trust products that state they are free of preservatives or chemical processing more.	190	47.5	120	30	90	22.5	400	2.45	0.741	60.0	12.14
18	It is best to buy local fruits and vegetables over imported ones if they are properly packaged and stored.	290	72.5	60	15	50	12.5	400	2.25	0.799	47.5	6.254
	Environmental awareness and sustainability											
19	I prefer products that are packaged in recyclable or compostable containers.	260	65	100	25	40	10	400	2.775	0.524	82.5	29.55
20	I encourage buying fruits and vegetables from companies or farms that use post-harvest technologies that reduce losses.	180	45	100	25	120	30	400	2.725	0.447	72.5	32.43
21	I believe that using modern storage technologies reduces food waste and protects the environment.	240	60	100	25	60	15	400	2.675	0.648	77.5	20.82
22	I believe that post-harvest processes have a direct impact on the environment and human health.	190	47.5	120	30	90	22.5	400	2.95	0.218	95.0	87.06
	Trust in local products											
23	I trust the quality of locally produced fruits and vegetables that bear the "Product of Local" label.	290	72.5	100	25	10	2.5	400	2.675	0.648	77.5	20.82
24	I believe that local products are safer than imported ones in terms of being free from harmful substances.	330	825.	50	12.5	20	5	400	2.475	0.671	57.5	14.15
25	I believe that imported products are more likely to use preservatives for preservation and transportation.	310	77.5	50	12.5	40	10	400	2.7	0.511	72.5	27.42
sum		7470		1900		630			668.	13.913		
average		2988.		76		252.			2.67	0.56		
%		74.%7		19%		6.3			89%			

The following can be observed from the data in Table (3) relating to the frequency distributions, percentages, arithmetic mean and standard deviation of the research variables:

1. It is noted from the data of Table (6) regarding the frequency distributions, percentages, arithmetic mean and standard deviation of the research variables related to awareness of post-harvest processes that the highest percentage of the sample agrees that the Iraqi consumer is concerned with the storage, packaging and transportation process when buying fruits and vegetables, as their percentage reached (95%), (75%) and (77.5%) respectively. This indicates that most Iraqi consumers have good health awareness when buying fruits and vegetables and take into consideration the storage, packaging and transportation processes. These responses came with an arithmetic mean of (2.95), (2.725) and (2.675) respectively and with a standard deviation of (0.218), (0.5) and (0.648) respectively. The highest percentage of the sample members agreed (57.5%) and (32.5%) were neutral (10) of them did not agree with the feeling of concern about their health from post-harvest processes such as treatment and chemicals. This came as a result of their lack of sufficient awareness. This came with an arithmetic mean of (2.475) and a standard deviation of (0.671).

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2. It is noted from the data of Table (6) regarding the frequency distributions, percentages, arithmetic mean and standard deviation of the research variables related to awareness of post-harvest processes that the highest percentage of the sample agrees that the Iraqi consumer is concerned with the storage, packaging and transportation process when buying fruits and vegetables, as their percentage reached (95%), (75%) and (77.5%) respectively. This indicates that most Iraqi consumers have good health awareness when buying fruits and vegetables and take into consideration the storage, packaging and transportation processes. These responses came with an arithmetic mean of (2.95), (2.725) and (2.675) respectively and with a standard deviation of (0.218), (0.5) and (0.648) respectively. The highest percentage of the sample members agreed (57.5%) and (32.5%) were neutral (10) of them did not agree with the feeling of concern about their health from post-harvest processes such as treatment and chemicals. This came as a result of their lack of sufficient awareness. This came with an arithmetic mean of (2.475) and a standard deviation of (0.671).
3. Regarding food quality and safety, it was observed that the highest percentage of the sample agreed that the storage method affects the quality and safety of fruits and vegetables (77.55%), while only 5% disagreed. This resulted in a mean of 2.7 and a standard deviation of 0.511. The highest percentage of the sample preferred to buy fruits and vegetables with minimal post-harvest spoilage (72.5%), with 25% remaining neutral and only 2.5% disagreeing. This resulted in a mean of 2.675 and a standard deviation of 0.52.
4. Regarding packaging, we find that the highest percentage of the sample agree that they prefer to buy fruits and vegetables that are packaged in a way that preserves their freshness, such as packaging in airtight bags, with a percentage of (87.5%) and (12.5%) of them were neutral. This came with an arithmetic mean of (2.9) and a standard deviation of (0.375). We also find that the highest percentage of the sample agrees that attractive appearance influences their purchasing decisions for fruits and vegetables (92.5%), while approximately 7.5% were neutral. This results in a mean of 2.9 and a standard deviation of 0.3. Furthermore, a large percentage of the sample (approximately 92.5%) agrees that hygienic packaging influences their purchasing decisions, while a smaller percentage (around 2.5%) disagrees. This results in a mean of 2.925 and a standard deviation of 0.346. This indicates the importance of choosing hygienic packaging for fruits and vegetables. Regarding the Iraqi consumer's preference for purchasing fruits and vegetables packaged in environmentally friendly, biodegradable, or recyclable containers, the highest percentage (90%) agreed, while 10% were neutral. This results in a mean of 2.775 and a standard deviation of 0.524. This indicates the importance of using environmentally friendly packaging and wrappers due to their impact on the environment.
5. We note with regard to price and cost that the highest percentage of the samples agree that the prices of fruits and vegetables that are stored in modern ways are high compared to other products, at a rate of (95%), while only (2.5%) of them do not agree. This came with an arithmetic mean of (2.775) and a standard deviation of (0.57). The highest percentage of the sample preferred to buy fruits and vegetables displayed in stores that care about cleanliness and modern display methods, at a rate of (72.5%), while (27.5%) were neutral. This came with an arithmetic mean of (2.25) and a standard deviation of (0.799). The highest percentage of the sample agreed that post-harvest processing costs (such as transportation, storage, and packaging) affect the price of products, at a rate of (85%), while (7.5%) were neutral and (7.5%) did not agree. This came with an arithmetic mean of (2.6) and a standard deviation of (0.701). The highest percentage of the sample preferred to support local produce even if its price was slightly higher, at a rate of (72.5%), while (27.5%) were neutral. This came with an arithmetic mean of (2.725) and a standard deviation of (0.548).
6. Regarding trust and information, we note that the highest percentage of the sample agree with giving importance to the information written on the product label (picking date, country of origin, method of preservation). When purchasing fruits and vegetables, (77.5%) of them were neutral, while (17.5%) were neutral and only (5%) of them did not pay attention to the information written on the product label. This came with an arithmetic mean of (2.15) and a standard deviation of (0.854). (47.5%) of the sample members were more confident in products that indicated that they were free of preservatives or chemical treatment, while (30%) of them were neutral and (22.5%) of them disagreed. This came with an arithmetic mean of (2.45) and a standard deviation of (0.741). (72.5%) of the sample members preferred to buy local fruits and vegetables over imported ones if they were packaged and stored correctly, while (15%) of them were neutral and (12.5%) of them disagreed. This came with an arithmetic mean of (2.25) and a standard deviation of (0.799).
7. Regarding environmental awareness and sustainability, we observe that the highest percentage of the sample (65%) prefers products packaged in recyclable or biodegradable containers. This indicates their environmental awareness, while 25% were neutral and 10% disagreed. The mean score was 2.775 and the standard deviation was 0.524. The highest percentage of the sample (45%) agreed that they encourage purchasing fruits and vegetables from companies or farms that use post-harvest technologies that reduce losses, while 25% were neutral and 30% disagreed. The mean score was 2.725 and the standard deviation was 0.447. The highest percentage of the sample (60%) agreed that using modern storage technologies reduces food waste and protects the environment, while 25% were neutral and 15% disagreed. The mean score was 2.675 and the standard deviation was 0.524. (0.648), and the highest percentage of the sample agreed that post-harvest operations have a direct impact on the environment and human health, at a rate of (47.5%), while (30%) of them were neutral and (22.5%) of them did not agree. This came with an arithmetic mean of (2.95) and a standard deviation of (0.218).
8. Regarding trust in local products, we observe that the highest percentage of respondents (72.5%) agree that they trust the quality of locally produced fruits and vegetables bearing the "Product of Local" label, while 25% are neutral and 2.5% disagree. This results in a mean of 2.675 and a standard deviation of 0.648. The highest percentage of respondents (82.5%) also agree that local products are safer than imported ones in terms of being free from harmful substances, while 12.5% are neutral and only 5% disagree. This results in a mean of 2.475 and a standard deviation of 0.671. Furthermore, the highest percentage of respondents (77.5%) agree that imported products are more likely to use preservatives for storage and transportation, while 12.5% are neutral and 10% disagree. This results in a mean of 2.7 and a standard deviation of (0.511).

Table (4): Results of the t-test (one-sample) and one-way analysis of variance (ANOVA) of the responses of the study sample regarding the analysis of consumer behavior towards post-harvest operations for fruit and vegetable crops

All questions	mean	Standard deviation	Evaluation	Degree of freedom	T calculated	F calculated	Significance	variance
	2.672	0.556	high	399	24.17	584*	*	0.309
) *P≤0.05(significant								

By tracking the results in Table (4), it becomes clear to us that the overall arithmetic mean value of the consumer behavior of the study sample towards post-harvest operations, which consisted of 25 items, reached (2.672) with a standard deviation of (0.556) and a high rating. The calculated (T) value was (24.17) at a degree of freedom of (399), which is a statistically significant value at a significance level of (0.05), indicating a significant positive trend in consumer behavior towards post-harvest operations. The variance was (0.309), indicating relative homogeneity in the responses of the sample members. The result obtained can be interpreted as the Iraqi consumer being aware of post-harvest

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operations for fruit and vegetable crops, and that packaging and quality are among the most influential factors in the purchase decision. The Iraqi consumer has confidence in the local product, but there is a need to enhance environmental and health awareness towards post-harvest operations.

Conclusions

1. Iraqi consumers are highly aware of post-harvest processes. They pay close attention to the storage, transportation, and packaging of fruits and vegetables, and are concerned about the health effects of post-harvest processes such as processing and the use of chemicals.
2. Storage and transportation methods affect the quality, safety, and freshness of fruits and vegetables, leading consumers to prefer products with minimal loss and waste, thus protecting both health and the environment.
3. Iraqi consumers prefer to buy produce packaged in a way that preserves its freshness, as attractive appearance influences their decision. They also prefer hygienic packaging in containers that are harmless to their health, environmentally friendly, and biodegradable or recyclable.
4. While fruits and vegetables sold in stores that prioritize hygiene and modern storage and display methods are more expensive, the quality justifies the higher prices.
5. Iraqi consumers prefer to support local products over imported ones, even if they are more expensive, provided they are packaged and stored properly. 6. The Iraqi consumer is interested in the information written on the product label regarding the harvest date, country of origin, method of preservation, and whether it is free of preservatives or chemical treatment.

Recommendations

1. Select packaging with a standardized label that clearly states the harvest date, country of origin, transport conditions, optimal temperature ranges, whether the product has been chemically treated or contains preservatives, and provides home storage instructions.
2. Enhance transparency through simplified tracking via QR codes, enabling consumers to monitor the product's journey and temperature throughout the supply chain.
3. Develop hygienic and sustainable packaging using biodegradable or recyclable materials and designs that preserve freshness through controlled ventilation, moisture-wicking linings, and labels that clearly indicate product quality.
4. Adopt display and pricing strategies that highlight the value of product quality in terms of hygiene, refrigeration, traceability, and sustainable packaging, justifying price differences and provide a section for near-ripe produce to minimize waste.
5. Empower local products through certification programs and trust labels that link them to proper packaging, a cold chain, and traceability data verifiable by consumers. 6. Establishing safe alternatives to post-harvest processing (non-thermal and low additive) and disseminating balanced scientific awareness about their safety, while addressing consumer health concerns.
6. Developing binding national standards for post-harvest processes, sustainable packaging, and labeling within a regulatory framework.
7. Supporting local fruit and vegetable production, storage, and packaging healthily and safely.

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