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Preparation of Standard Operating Procedures (SOP) of Broccoli Handling at PT. X Bandung

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Abstract: PT. X is a company that is classified as an agroindustry, especially in the field of post-harvest handling of vegetables and fruits. Some supermarkets in the Jakarta, West Java and Banten regions are consumers of the company, of which broccoli is one of the vegetable commodities that have high demand and high selling prices. Until now PT. X has not followed the standard of good vegetable handling activities in handling broccoli, which raises several problems, including: (1) excessive use of packaging materials, (2) various handling times, and a decrease in quality. This study aims to develop a Standard Operating Procedure (SOP) for handling broccoli at PT. X, as an effort to improve broccoli handling activities. Standards that are structured are useful for handling broccoli in similar companies. Standards are made to consider the rules of SOP compilation according to SNI and Good Handling Practice according to the Minister of Agriculture Regulation No: 73/Permentan/OT.140/7/2013, with research stages: (1) in-depth observation of handling activities, in-depth interviews, data collection on quantities operating time for each process and identification of technical problems, (2) literature study related to observations and problems found, aimed at improving procedures and problem solving, (3) preparation of SOPs and (4) verification to experts and companies. Through this study, SOPs were prepared which resulted in improvements of 39% items. The important points of improvement are: (1) employee self-sanitation, (2) sanitation of equipment and work tools, (3) controlled and recorded packaging usage, (4) the determination of standard operating time, and (5) work instructions for each process successfully arranged.

Keywords: standard operating procedures, broccoli, good handling practice, process and product quality

1. Introduction

Broccoli is a prospective agricultural commodity to be developed as an agro-industrial activity in Indonesia. Broccoli has high economic value and benefits. Broccoli production in Indonesia is still low, both in quality and quantity. This broccoli production area is dominated by highland areas where broccoli is able to adapt well, such as Lembang (West Java), Brastagi (North Sumatra), Malang (East Java), and Bedugul (Bali) [1]. In Indonesia, broccoli consumption in Indonesia tends to increase every year. The prospect of domestic demand for vegetables tends to increase. This is in line with the increase in population, increasing community income, as well as the development of urban, industrial and tourism. Data from the Central Bureau of Statistics regarding consumption that has increased every year is directly proportional to the increasing market demand, as shown in Figure 1 [2]. This increase in demand needs to be balanced with a good supply of broccoli in terms of quality. Presenting quality broccoli requires special treatment starting from the upstream to downstream sub-systems so that product quality is maintained until the end consumer.

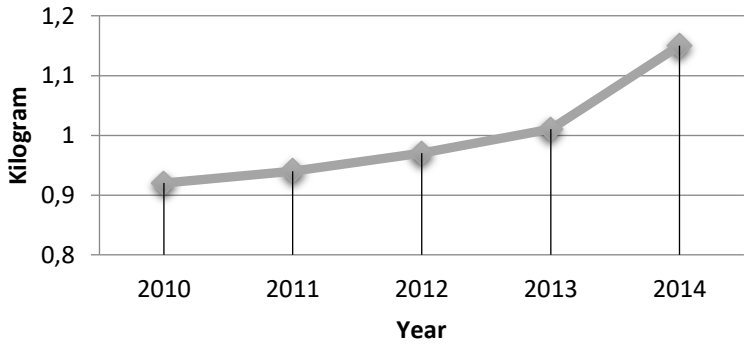

Figure 1. Broccoli consumption in Indonesia per capita in 2010-2014

PT. X, is a company engaged in post-harvest handling of 127 types of fruits and vegetables, packing and then supplying it to supermarkets located in DKI Jakarta, West Java and Banten, namely DC Carrefour (District Central), Hypermart, Lottemart, Market City, Hero, Ramayana and Aeon. Broccoli is one of the vegetable commodities which has a high demand (170-200 Kg) and has a high selling value. It is unfortunate that PT X has not implemented a standard post-harvest handling of broccoli properly, thus causing problems such as excessive use of packaging materials, length of handling that is still not standard, and lack of self-sanitation activities. These problems have an impact on inefficiency and low quality of handling, such as broccoli stems broken, broccoli packed withered.

Pursuant to the regulation of the Minister of Agriculture of the Republic of Indonesia Number 73/Permentan/OT.140/7/2013 concerning Good Handling Practice (GHP) which requires business actors to follow a food safety program by compiling a Standard Operating Procedure (SOP), then PT. X needs to prepare a SOP for post-harvest handling of broccoli [3]. The application of SOP is motivated by consumer demand for products that are more better from the aspect of quality, and quantity to timeliness of acceptance [4].

PT. X in carrying out its activities only has one SOP not written and generally applicable. While the written SOP for each vegetable commodity have not been compiled. This is a weakness in post-harvest handling activities, given that each vegetable commodity has different characteristics. Therefore, it is very necessary to develop special SOPs regarding post-harvest handling of broccoli

This study aims to compile SOPs for broccoli post-harvest handling to increase productivity, efficiency and as an effort to maintain product quality. In addition, SOP is expected to be able to be used as a SOP specifically in post-harvest handling of broccoli by similar companies.

The scope of the research is the preparation of SOPs related to employees as operators, production tools used, standard handling time and Work Instructions (IK) from broccoli post-harvest handling activities starting with receiving, sorting, trimming, grading, packaging, labeling, checking / TLM, and product distribution. All of these activities are carried out by PT. X.

2. Materials and Methods

This research is classified as applied research that is an attempt to get a solution to the problem through engineering methods to compile SOP for handling post-harvest broccoli at PT. X. The preparation of the SOP refers to the regulation of the Minister of Agriculture of the Republic of Indonesia No: 73/Permentan/OT.140/7/2013, and ISO/TR 10013 namely "guidelines for quality management system documentations" [3,5].

This research was carried out with the following steps: (1) in-depth observation of handling activities, in-depth interviews, data collection on quantities operating time for each process and identification of technical problems, (2) literature study related to observations and problems found, aimed at improving procedures and problem solving, (3) preparation of SOPs and (4) verification to experts and companies.

In steps no (1) and (2) the topic is understanding each type of broccoli post-harvest handling process. Searching for each process includes the objectives, scope, main and supporting materials, work procedures, equipment used, operators and other related employees, related work guidelines, work environment, and the time needed to complete the process. Especially regarding the completion time of a process, the cycle time is measured to then set the normal time, then the standard time of the process is determined. The normal time of a process is the cycle time multiplied by the rating factor (using Westinghouse System of Rating), while the standard time of a process is the normal time added to the allowance factor. Standard time determination of a process in this research refers to the rules of determining "standard time" for work that has a cycle [6,7] .

The results in steps no (1) and (2) are used to compile the SOP for each process. The preparation of the SOP substance (step number (3)) refers to the regulation of the Minister of Agriculture of the Republic of Indonesia Number 73 / Permentan / OT. 140/7/2013 concerning Good Handling Practice (GHP), while the writing guide refers to ISO / TR 10013 is modified. The compiled SOP is then verified by the expert and the company to evaluate the possibility of its application which includes comprehensiveness, completeness of SOP material, and logical work procedures. If the evaluation results of the SOP draft are declared as not fulfilling all three of these, then the SOP design is corrected. After verification activities, a trial of the implementation of SOP was conducted as a form of validation of the draft SOP.

3. Results and Discussion

3.1. Series of Broccoli Post-Harvest Handling Processes

Description of the results of an in-depth understanding of the broccoli post-harvest handling system that occurred at PT. X is based on the work process framework from upstream to downstream. The series of work processes (upstream to downstream) starts from the availability of raw materials (ie the arrival of harvested broccoli in a basket transported by a box car parked in front of the workshop door) until broccoli is packed with secondary packaging ready to be distributed to each supermarket (first buyer). A series of broccoli post-harvest handling processes are presented in Figure 2.

3.1.1. Receiving and Sortation

Broccoli from supplier received by PT. X is in a plastic container, it is clean from leaves, the size of weight and physical condition varies, for example there are black or yellow spots on the part of broccoli flowers. Therefore, the sorting process is carried out.

The sorting process aims to get good quality broccoli based on the diameter of the flower, stalk length, weight and color. The sorting process is carried out manually by the operator through checking the diameter of the flower, the length of the stalk and the color of the broccoli flower. Broccoli is held by the operator without using gloves. This has the potential to accelerate the decay of broccoli due to exposure to contaminants from the hands of employees [3]. The sorting process takes place in a workshop with 2 sides of an open wall, so it has good lighting because it is always carried out during the day. There are at least 3 containers as a container to separate broccoli that passes sorting with broccoli which does not pass sorting.

Broccoli, which is of good quality in containers, is weighed at the same time to find out the amount of payment to suppliers. Broccoli in containers as temporary storage is pushed on the floor (to reduce the operator's workload due to the relatively heavy weight of broccoli (30 kg) per container) towards the trimming process. Broccoli passes sorting can be seen in Figure 3. The characteristics of broccoli set by the company to pass the sorting process can be seen in Table 1.

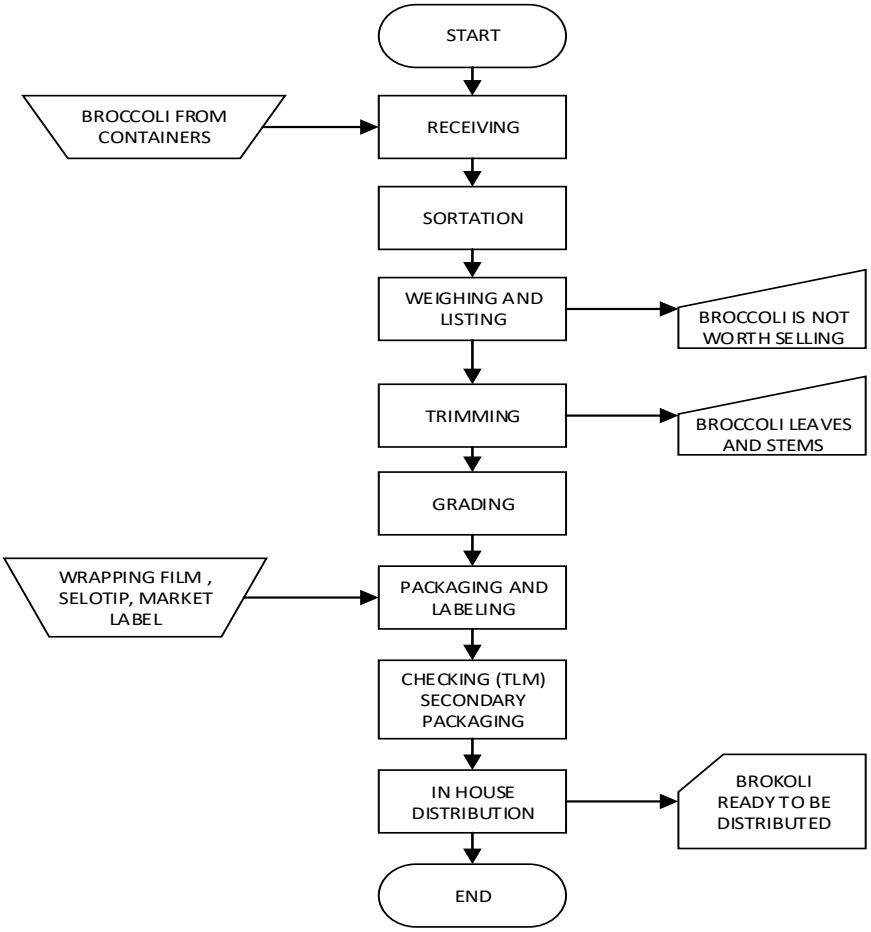

Figure 2. Operating Process Chart for Broccoli Post Harvest Handling at PT. X

Figure 3. Physical appearance of broccoli that passes sorting; Source: Research team, 2018

Table 1. Characteristic requirements of broccoli that pass sorting

No	Attribute	Specification
1	Flower diameter	9 cm – 15 cm
2	Stem length	9 cm – 10 cm
3	Weight	250 gram – 350 gram
4	Color	Flowers are dark green and have no black or yellow spots.

Source: Processed data research, 2018

3.1.2. Trimming and Grading

In the process of trimming and grading, broccoli is examined against the presence of pests and diseases such as caterpillars and black spots, then the stem is removed from the bulge by cutting using a knife. Broccoli is held using the left, and the knife is on the right hand, because the right hand is

considered to have a better balance. Broccoli stems that have been cleaned are cut to a maximum length of 10 cm, to meet the standards set by the market, and avoid packaging damage in distribution activities. The remaining cutting stems are weighed and recorded at the receiving part as a factor to reduce overall broccoli weight to adjust the amount of payment to suppliers.

Trimming tools used in this activity are knives, sorting tables and containers that are prepared in a clean condition, but sometimes used in a dirty state. This is because companies that have not set hygiene standards for trimming activities, in this activity employees do not use gloves. This can endanger operator safety, considering the use of knives as trimming tools. Workers who do not use completeness can be seen in Figure 4.

Figure 4. The process of trimming broccoli; Source: Research team, 2018

Broccoli is transferred to the grading operator which is located on the right side of the trimming operator for grading. Broccoli is classified into 2 grades (grades A and B), stored in different container containers. The classification of broccoli in this company is determined by the shape, color, texture and size of the flower. The criteria for each broccoli grade can be seen in Table 2.

Table 2. Characteristic requirements of broccoli that pass so

Quality Criteria	***Grade* A**	***Grade* B**
Diameter	9-15 cm	9-15 cm
Stem length	Max 10 cm	Max 10 cm
Weight	200-450 g/ piece	200-450 g/ piece
Color and shape of flowers	Even dark green, round like umbrellas, fresh flowers and stalks, free of disease, relatively the same size	Even dark green, round like an umbrella, fresh flowers and stems, free of disease, size varies greatly
Surface	Seamless, non-defective, non-contaminant	Seamless, slightly defective, non-contaminant
Packaging	*Wrapping*	*Wrapping*
Quality	Equally	Varies
Shelf life	One day	One day
Customer	*Medium & high income*	*Low income*

Source: PT. X, 2018

3.1.3. Packaging and Labelling

The packaging process begins by arranging the hand wrapper machine to turn on and showing the heat scale at number 3. The packaging used is wrapping Polyvinyl chloride-based film, has a width of 30 cm in an effort to reduce the level of mechanical and biological damage to broccoli. The packaging process is carried out in the afternoon until the evening, carried out on a work table made of aluminum with a height of 90 cm, lighting coming from outside the room because the iron curtain is converted as a wall in the packing room, while at night the lighting comes from fluorescent lamps colored white. Adhesive material in the form of transparent masking tape to avoid damage due to wrapping of films

that do not stick well. The company has not set a maximum standard for using adhesive tape. Here the problem arises in the form of careless use of masking tape and tends to be excessive.

The next process is labeling using a sticker that contains information about the company name. The stickers are placed on the outside of the packaging right in the middle of the broccoli flower. Sticker design differs according to the purpose of delivery. Broccoli that has been labeled can be seen in Figure 5.

(a) (b)

Figure 5. (a) Broccoli that has been packaged; (b) labeled

Packaged broccoli is then stored in containers that have been coated with scrap paper, to minimize damage to the packaging and bruising on broccoli, which is caused by collision and friction with the cavity of the container that has a hollow surface and has some sharp parts. The use of used paper is intended to reduce the amount of company expenditure.

3.1.4. Total Loss Management (TLM) and Secondary Packaging

Next is the process of Total Loss Management (TLM) which is weighing broccoli using a sitting scale, broccoli weight data recorded and adjusted to the order amount by the admin. The operator in this process is at least 2 people, one is assigned as an admin who enters broccoli data on the computer, and another weighs. Broccoli is then moved to the distribution section, to be included in each container according to their respective order quantities, while checking the quality of the packaging. If damage occurs, it will be repackaged by the packaging section. Admin checks the order data on the computer, then weighs broccoli according to the number of orders and the destination of delivery, with excess tolerance of 1 broccoli or about 350 grams for each shipping destination. This addition is to anticipate the differences in scales used between PT. X with the ordering party. Broccoli is packaged using cardboard boxes with a length of 50 cm, 30 cm wide and 40 cm high.

3.1.5. In House Distribution and Shipping

There are different treatments in the distribution process. This is based on an agreement between the company and the buyer, including the determination of the selling price. The purpose of shipping to DC Carrefour is the main priority of shipping, because it provides greater benefits compared to other shipping destinations. Broccoli sent to DC Carrefour is classified as grade A, stored temporarily on wooden beams. As for shipping to Ramayana, Aeon, Lotte and Hero, broccoli which is classified as grade B is put into containers along with other commodities.

Broccoli shipped at 01:00 AM using a box car without cooling, the selection of the delivery time aims to avoid congestion on the highway, and avoid high temperatures so that the quality of broccoli is maintained in the course of 140 km.

3.2. Identification of Problems and Improvements to Broccoli Post Harvest Handling Systems

In-depth analysis was carried out on every work process related to the work system that actually happened compared to the Good Handling Practice guidelines. Analysis material refers to aspects of the objectives, scope, main and supporting materials, work procedures, equipment used, operators and other related employees, related work guidelines, work environment, and the time needed to complete the process. In the analysis include discussing the problems that occur in each process and or event

between processes. The overall results of the problem analysis are presented in Appendix A Table 1. Improvements were made as much as 39%, in the form of SOP preparation, preparation of work instructions, determination of standard time, recording of container materials used, as well as determining the maximum limit for the use of container materials.

3.3. Preparation of Work Instructions

Work instruction is a work mechanism document that regulates in detail and clearly the sequence of activities which only involves one function as a support for quality procedures. Procedures usually involve several parts and describe the process or activity in general, in contrast to work instructions that describe a particular process, carried out by certain parts, and contain a detailed mechanism [5]. General work instructions consist of: (1) Description of the equipment needed; (2) The main material and supporting materials used; (3) Work activities, including preparation activities to implementation; (4) Parties involved in every job; (5) Job tolerance; and (6) Examination. Work instructions are prepared for each process in the post-harvest broccoli handling activities. The preparation of instructions follows the rules as stated above.

3.4. Employee Self Sanitation and Use of Work Completeness

The employee's self-sanitation activities are one of the important factors in the implementation of agricultural production activities, these activities prevent agricultural products contaminated by pathogenic microbes carried by human hands. Employee self-sanitation activities can be carried out with hand-washing activities before and after handling agricultural products, proper hand washing includes the use of soap, rubbing the palms together to produce foam, alternately washing the back of the hand, rubbing between fingers and inside nail, then rinse using clean running water [8].

Apart from hand washing activities, the use of employee work completeness is an effort to protect agricultural products from contamination from human hands, one of which is the use of gloves. There are two types of gloves commonly used, namely thick rubber gloves that can be used repeatedly and disposable gloves [8].

The use of gloves recommended in handling post-harvest vegetables is thick rubber gloves that have a thickness between 0.3 mm to 0.6 mm, because they are considered to have better resistance compared to disposable gloves, considering the use of pesticides (chemicals) in aquaculture who can irritate the hands of employees. Included can be used many times, thereby reducing the cost of purchasing production equipment. Gloves must be washed and replaced regularly to ensure hygiene and do not cause contamination of the product. In addition, the use of gloves is useful as a protective tool for employees if the implementation of activities using sharp tools such as knives [9].

3.5. Recording and Determining the Maximum Use of Packing Materials

The purpose of recording and determining the maximum limit for the use of raw materials is to improve production efficiency, encourage compliance with company policies, and as an effort to check the use of container materials. Recording method can be done by recording continuously about incoming and used items, so that every item used in each activity can be known at any time [10].

Recording at PT. X can be done by weighing the roll wrapping film, then recorded in a special book that contains the recording of the use of goods or packaging materials used every day, with a writing format that shows the number of packaged broccoli, the initial weight of packing material, the final weight of the packing material after use and the reduction results between the initial weight and the final weight of the packing material.

Determination of the maximum limit for the use of containerized materials is done by measuring the length of masking tape when employees carry out packaging activities. The masking tape length can be seen in Table 3.

Table 3. Tape length for packaging activities

No	Tape Length (cm)						
	Employee						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1	6,0	4,3	3,0	4,5	4,5	3,0	4,0
2	4,5	5,1	4,5	3,0	5,0	4,0	5,0
3	5,0	5,0	5,0	3,5	5,3	4,0	3,5
4	4,5	5,5	4,0	3,5	4,8	5,0	4,0
5	5,0	5,0	5,5	6,0	4,0	3,5	6,0
Average							4,5

Source: Processed data research, 2018

Suggestions for improvement regarding the determination of the maximum limit for the use of masking tape for packaging activities are carried out by measuring each of the first joints of the right hand thumbs of the employees. Employees are expected to do tape withdrawal activities limited to the first joint joints. Data from the first joint segment measurement of the employee's right thumb can be seen in Table 4.

Table 4. Employee's first thumb length

Employee	1	2	3	4	5	6	7	Average
First thumb length (cm)	3,0	2,9	3,1	3,1	2,8	2,7	3,2	3,0

Source: Processed data research, 2018

From each of the data obtained, it can be seen that the average use of 4.5 cm masking tape and improvement advice given based on the first right hand length of the thumb is 3 cm, so that the suggested improvement can save as much as 1.5 cm of tape for every packaged broccoli or 33.3%.

3.6. Determination of The Standard Time for Each Process

In determining the standard time of each process, the first step is to measure the cycle time, then calculating the normal time using the Westinghouse adjustment factor, then by adding the allowance time then the standard time is obtained. Calculation data can be seen in Table 5. There is a difference between the standard time and the average cycle time of the measurement results. Standard time is relatively longer than the cycle time. This is due to the calculation of standard time included with the value of adjustments and concessions, which take into account several aspects, namely the type of activities, skills, working conditions, and employee consistency.

Table 5. Time Measurement (in seconds)

No	Process	Cyclic time	Rating factor	Allow-ance factor	Normal time	Standard time
1	Sortation	5,4	0,14	14	4,7	5,5
2	Weighing	10,0	0,12	29	8,6	10,3
3	Trimming & Grading	8,4	0,13	27	7,3	9,7
4	Packaging	17,9	0,09	27	16,2	21,4
5	Compile a Packaging Cardboard	183,2	0,12	28	161,2	214,4
6	Weighing for distribution	4,0	0,12	21	3,4	4,1
7	Stepping speed in distributing (10 m)	8,5	0,12	21	7,3	8,7

Source: Processed data research, 2018

Allowance factors are given for three reasons, namely personal needs such as urinating, relieving fatigue, as well as disturbances that may occur and cannot be avoided by employees, such as having to sharpen cutting equipment. Adjustments are given to assess how far the employee's irregularities are

caused by working without seriousness, very fast as if time is hunted, employees encounter difficulties such as poor room conditions, and the appropriateness of the assessors who are lacking because they are not experienced in the type of work being measured [6].

4. Conclusion

The results of this study are the composition of standard operating procedures (SOP) post-broccoli handling at PT. X. The results of the analysis showed that the required improvements as much as 39% of the entire process in handling broccoli post-harvest activities at PT. X. These improvements are in the form of preparing work instructions, determining employee self-sanitation, determining the use of completeness of employee work, determining the standard time of activities, and determining the maximum limit for the use of container materials.

5. Patent

The Standard Operational Procedure for post-harvest handling of broccoli that has been successfully compiled is currently being completed in accordance with the requirements for obtaining the proposed patent in order to obtain its patent rights through the patent service institute of Padjadjaran University. Therefore this SOP cannot be included in this paper.

Appendix A

Activities	Good Handling Practice (GHP)	Real Condition	Suit-ability	Details
Receiving	The existence of calibrated scale.	1	Yes	
	Using a proper and clean transport container	1	Yes	
	The existence of loading dock shelter	1	Yes	
	The existence of receiving work instruction	0	No	The work instruction is designed as a guideline for activity
	Weighing the container and its content	1	Yes	
Sorting	Hiring skilled and trained workers	1	Yes	
	The workers do self-sanitation	0	No	The workers are required to do self-sanitation and use hand gloves before the activity begin
	Weighing and recording correctly	1	Yes	
	Separating products that qualified and not qualified	1	Yes	
	The existence of sorting work instruction	0	No	The work instruction is designed as a guideline for activity
	A clean place for sorting	1	Yes	
Trimming	Hiring skilled and trained workers	1	Yes	
	The workers do self-sanitation	0	No	The workers are required to do self-sanitation before the activity begin
	Transferring the products that have been trimmed well	0	No	The workers are required to transfer the products slowly and carefully
	The existence of trimming work instruction	0	No	The work instruction is designed as a guideline for activity
	Using a proper tools for trimming	1	Yes	
	Using a clean tools	0	No	The workers are required to clean the equipment before use
	The workers are using work equipment	0	No	The workers are required to use work equipment
Grading	Hiring skilled and trained workers	1	Yes	
	Classifying product based on specified quality	1	Yes	
	Putting product on a container based on its quality	1	Yes	
	The existence of grading working instruction	0	No	The work instruction is designed as a guideline for activity
	Using a good and clean tools or machine	0	No	The workers are required to clean the equipment before use

Activities	Good Handling Practice (GHP)	Real Condition	Suit-ability	Details
	The workers are using work equipment	0	No	The workers are required to use work equipment
Packaging	The existence of packaging work instruction	0	No	The work instruction is designed as a guideline for activity
	Preparing tools and materials for packaging	1	Yes	
	A sign on package	1	Yes	
	A temporary storage and additional protective material	1	Yes	
	The workers listing the amount of used packaging materials	0	No	The workers are required to record the amount of packaging that used
Labelling	Preparing product and label that will be used	1	Yes	
	Preparing a strong product label /persistent	1	Yes	
	The existence of labelling work instruction	0	No	The work instruction is designed as a guideline for activity
	Using informative label	1	Yes	
Total Loss Management (TLM)	The existence of calibrated scale	1	Yes	
	The existence of TLM work instruction	0	No	The work instruction is designed as a guideline for activity
	Using a good and clean container	1	Yes	
	Recording the amount of products	1	Yes	
	Preparing tools and materials for packaging	1	Yes	
	The existence of TLM work instruction	0	No	A guideline for broccoli packaging is designed
	A sign on package	1	Yes	
	Preparing a temporary storage	1	Yes	
In House Distributing	Using a good and clean container	1	Yes	
	The existence of distribution work instruction	0	No	The work instruction is designed as a guideline for activity
	Recording the amount of products	1	Yes	
	1 =	27	61%	
	0 =	17	39%	

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