

WAKAME
(Undaria pinnatifida)

PROCESSING AND QUALITY CONTROL

**Translation of Japanese technical document for the Fisheries Research
and Development Corporation 1993**

(Department of Primary Industry and Fisheries, Tasmania)

CONTENTS

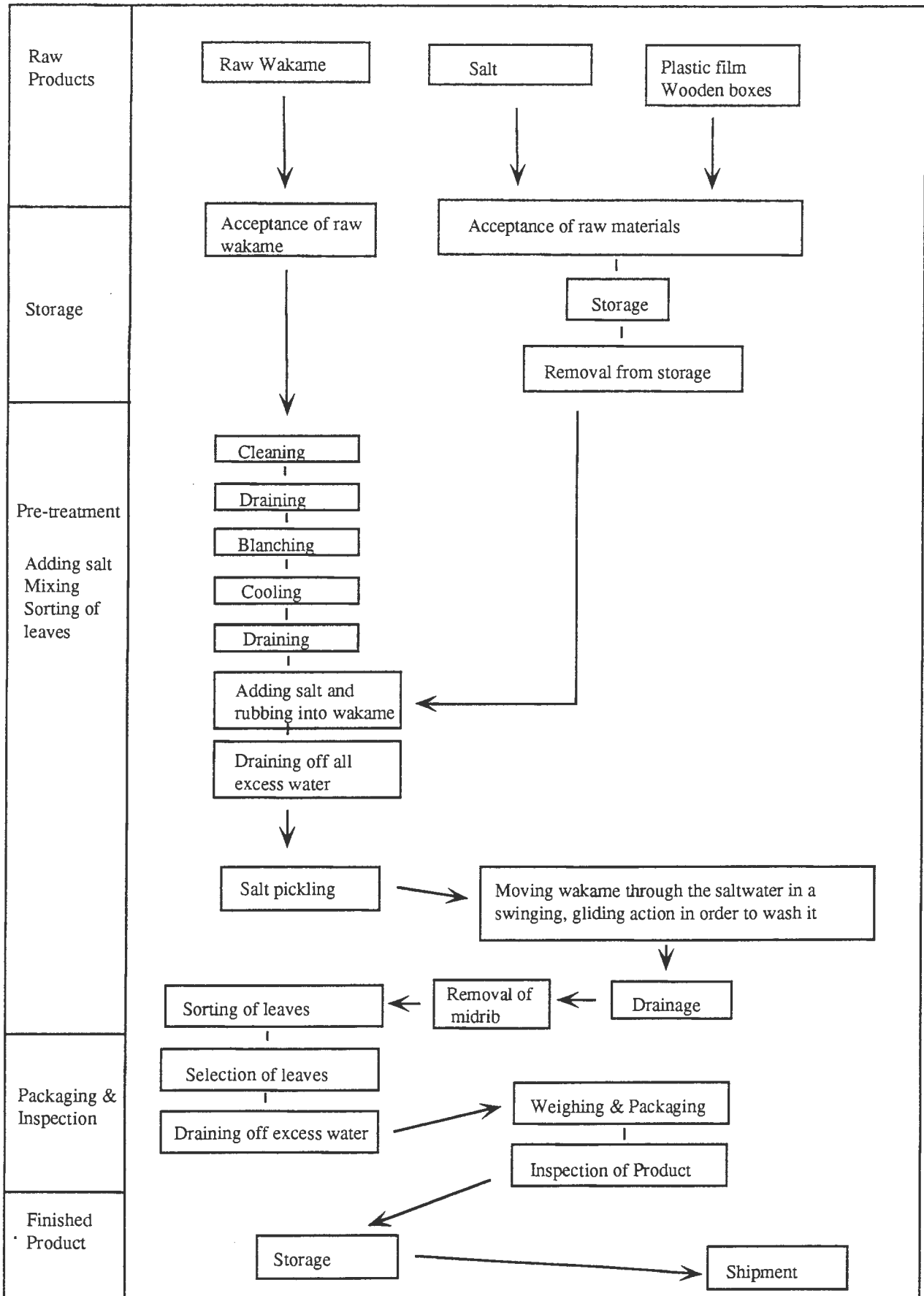
	Page
1 Quality Control Techniques	2
1.1 Dried Wakame - Manufacturing Plan	6
1.2 Receiving and Storage of Equipment and Raw Materials	6
1.3 Pre-treatment of the Raw Wakame	14
1.4 Drying	16
1.5 Arrangement/Sorting	22
1.6 Weighing and Packaging	26
1.7 Product Inspection Standards	26
1.8 Storage and Shipment of the Product	26
2 Processing at the Place of Harvest of the Raw Wakame	28
2.1 Manufacturing Plan	28
2.2 Receiving and Storage of Equipment and Raw Materials	28
2.3 Pre-treatment	28
2.4 Blanching	30
2.5 Cooling and Drainage	36
2.6 Adding Salt	36
2.7 Arrangement of Leaves	37
2.8 Weighing and Packaging	37
2.9 Inspection of Product	38
2.10 Storage and Shipment of Product	38
3 Blanched Salted Wakame	42
3.1 Manufacturing Plan	42
3.2 Receiving and Storage of Raw Wakame and Salt	42
3.3 Adding Salt and mixing	42
3.4 Sorting of the Wakame	47
3.5 Weighing and Packaging	47
3.6 Inspection of Goods	48
3.7 Storage and Shipment of the Goods	48

QUALITY CONTROL TECHNIQUES

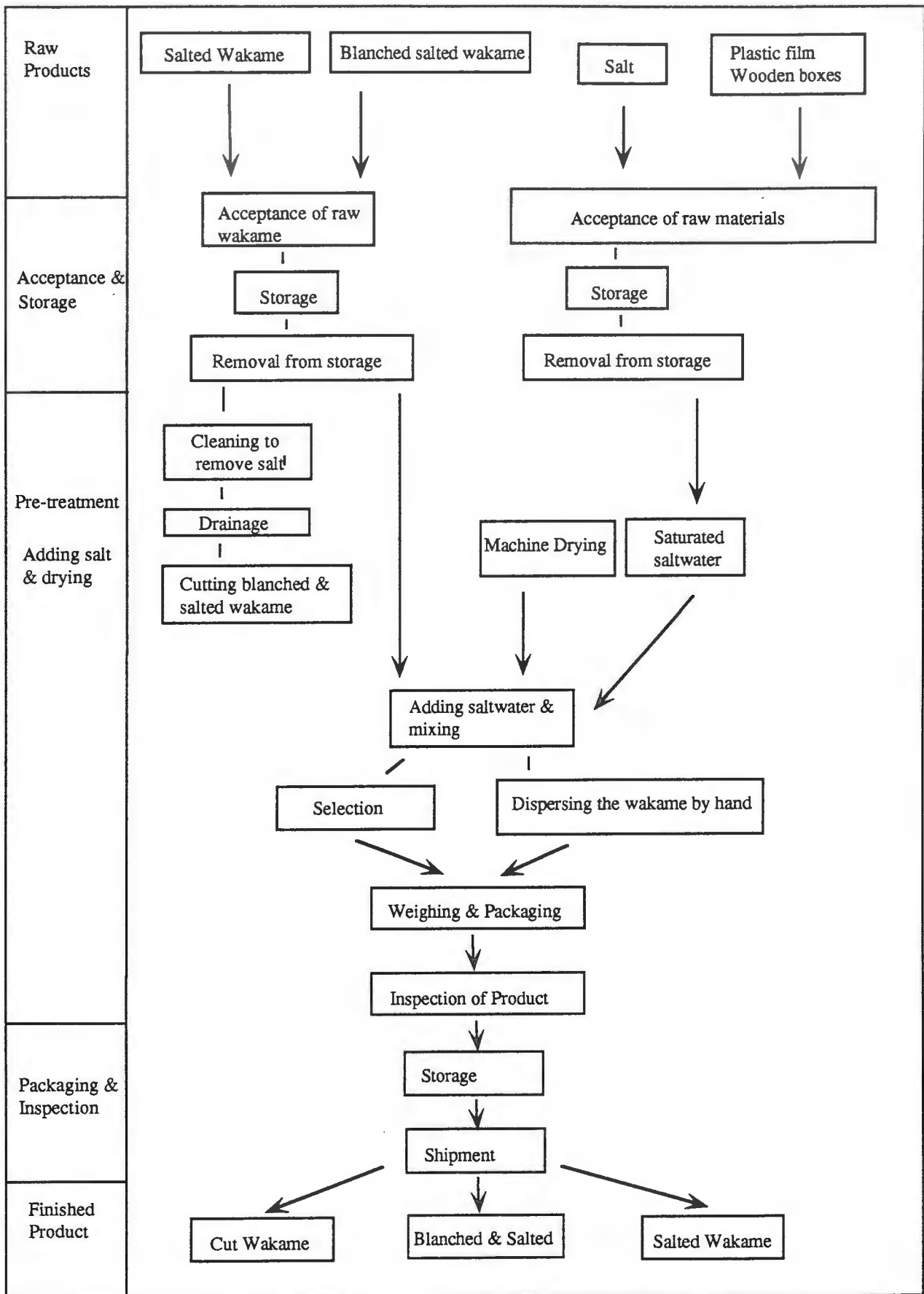
1. STANDARD MANUFACTURING PROCESS DIAGRAM

- 1.1 Here we have chosen to look at wakame's main products. These include dried wakame, rubbed wakame, thread wakame, sheet wakame, ash-covered (thread)wakame, cut wakame, salted wakame, and blanched, salted wakame.
- 1.2 The processing diagram for salted wakame and blanched, salted wakame shows two different methods available for processing: a) is at the harvesting place, and b) is at the market place.
- 1.3 We have not dealt with the method of processing dried wakame and thread wakame in this document.
- 1.4 Here we have dealt with the standard manufacturing process. Processing varies depending on the place of harvest, therefore some processes have not been dealt with.

MANUFACTURING PROCESS OF SALTED WAKAME AND BLANCHED WAKAME AFTER HAVING



MANUFACTURING PROCESS OF SALTED WAKAME AND BLANCHED WAKAME AT THE MARKET



PRINCIPAL MACHINERY EQUIPMENT AND CONTROL ITEMS

(For Dried Wakame and Blanched Salted Wakame)

5

* = machinery used for processing at the site of harvest of raw wakame

	Acceptance & storage of raw wakame, salt & packaging material	Pre-treatment	Sorting of Leaves	
Machinery Equipment	A Refrigerator A Freezer A warehouse for storing materials Inspection room Tools for Inspection Baume hydrometer A cylinder Scales Infa-red ray moisture gauge	Cleaning - cleaning place - cleaning tub Drainage - draining bench - draining basket	A desalinization tub A shredder A sifting machine *A boiling tub A crane A conveyor belt *A cooling tub	*A draining basket *A netted bag A tool for removal of midrib An ash dispensing machine (rotating) A hydroextractor - pressure type - centrifugal type
Control Items	Refrigerator - temp. & humidity Storage of salt		Boiling - temperature - length of time Centrifugal Hydroextractor - no. of rotations - length of time	Ash dispenser - no. of rotations - length of time Temperature of desalinization
	Drying	Adding salt & mixing	Weighing & Packaging	Storage & Shipment
	*A drying place *A drying bench A drainboard A rope dispensing machine A dark stabilizing room *A drying system - box style dryer with shelves which receive hot air - basic hot air room	Machine/Board to rub the wakame with salt Mixer Sorting Table - stainless steel - wooden - plastic Conveyor Belt *A salt-pickling tub *A cleaning tub *A draining bench & baskets	Scale - platform - lever - automatic checkers - semi-automatic Packaging - a hand operated package heat sealer - an automatic package heat sealer Inspection room - baume hydrometer - a cylinder - infra-red moisture gauge	Refrigerator Conveyor belt
Control Items	Temperature Humidity Air current in the dryer length of time	Mixing - no. of rotations - length of time Salt pickling - ratio of salt - length of time	Adjustment of scales Dissolution by heat - temperature - length of time	Refrigerator - temp. -10 to -20°C Humidity - 80 to 90%

I Essential Points in the Manufacturing and Quality Control Techniques of Blanched Salted Wakame and Dried Wakame

Dried wakame (Hoshi) and salted wakame are some of the typical by-products of Japanese Dried Wakame (Kanso).

Put forward here are the essential points of the manufacturing and quality control techniques of both blanched salted wakame and dried wakame:

The manufacturing process of blanched salted wakame is different at both the place of harvest and at the market place (the place where it is sold).

1.1 Dried Wakame - Manufacturing Plan

In order to produce a certain quality of wakame within the planned cost guide-lines and time limitations, a manufacturing plan must be made. The quantity of production, quality of materials and product, manufacturing costs and so on must be decided upon and also a trial calculation of necessary materials must be done.

1.1.1 Essential Points of the Manufacturing Plan:

- a) A plan should be made based upon the yearly production and sales figures and also on that years production target.
- b) In setting up a practical, concrete plan, one should consider dividing the year into yearly, quarterly, monthly and weekly terms as well as the grade and quality of the wakame, the destinations of shipment and so on.

1.1.2 Items to be incorporated into the Manufacturing Plan:

- a) Manufacturing Method.
- b) The quantity of wakame products to be manufactured, based upon the quality of the raw materials and the demands of various companies.
- c) Quality Standard.
- d) Number of Workers.
- e) Quantity, standard of quality and types of raw materials.
- f) Target cost.

1.2 Receiving and Storage of Equipment and Raw Materials

1.2.1 Quality of the raw wakame:

Types and special features of the wakame growing environment:

Northern wakame grows to about two metres long. Its leaves are nutritious, succulent and have a deep lobation.

In comparison, Southern wakame is a little smaller and the lobation is shallow. The leaf thickness is thinner and more supple than the Northern type. However,

the same kinds of wakame grown outside of Japan have a deeper lobation and are more succulent and shiny.

The wakame which grows in the sea where river water flows in has a fine lustre because of the abundance of such nutritious elements as phosphoric acid, nitrogen and potassium. However, there are also cases of wakame growing in the sea where water flows in from built-up living areas and factories and these waste products badly affect its growth.

Concerning the influence of the depth of water on the quality of wakame, where it grows in water which is more than two metres deep, a deterioration in quality can be seen.

1.2.2. Special Characteristics of Wakame at Harvesting Time:

In the early stages of harvesting, the body leaves of the Wakame are thin and soft and the midrib is also edible, therefore the yield rate of the product at this stage is high. On the other hand, in the later stages of harvesting, the body leaves harden and wither, its colour fades and much of it will be damaged by blight and harmful, noxious insects. Because the midrib becomes enlarged, it must be removed, therefore the yield rate of the product declines.

1.2.3 There are times during the growth of wakame when it undergoes damage such as parasitic infestation, damage by blight or by polluted water. Such damage not only hinders the growth of the wakame but also brings about a decline in the yield rate and quality of the product.

The Main Blight and Noxious Insects are as follows:

- a) Eating damage by Arthropods
e.g. (skeleton shrimp)
Eating damage by herbivorous fish
e.g. (Rabbit Fish; *Siganus Fuscescens*)
(Sea Hare; Tethyidae Aplysidae)
- b) Parasitic Infestation:
 - i) Tentacled animals
e.g. Sea Moss; Polyzoan
 - ii) Eelworms/Nematode
 - iii) Diatomaceae
- c) Damage by bacterial infestation (creating holes in the leaves of the wakame)
e.g. Ascidium bacterial disease
- d) Pollution and corruption by:
 - i) Waste oil
 - ii) Contaminated water
 - iii) Other floating matter

1.2.4 Receiving of the Raw Wakame at the Factory:

Acceptance of the wakame depends upon the quality of the goods which is based upon the receiving standards of the factory.

A record of the product's origin and grade is necessary for the manufacturing control of the wakame.

Diagram 2 shows an example of acceptable standards:

	ITEM	STANDARD
QUALITY CONDITIONS	Body Quality	Supple and in good condition
	Lustre	Shiny blackish - brown. There should be no faded colours, red or withered leaves.
	Condition	<ul style="list-style-type: none"> . There should not be any insect damaged leaves or leaves of short length. . The midrib should not be excessively crooked. . The leaves should not be excessively wide or thin. . The leaves should not be excessively curled over. . The leaves should not be excessively wide or thin.
	Fragrance	The wakame should have its own particular fragrance, not an offensive smell.
	Dirtiness	There should be hardly any soiling of the Wakame.
	Impurities	Again, there should be very few.
	Foreign Matter	Sea shells and so on should not be found amongst the leaves.

It is essential to do a rapid processing treatment on the wakame soon after harvesting it from the water because it is impossible to completely prevent deterioration of the product whatever method of storage is used.

Consequently, the raw wakame accepted by the manufacturer should be of a sufficient quantity for the daily manufacturing plan as it is desirable to treat the raw wakame within several hours of harvesting from the water.

1.2.5 Special Points of Consideration Concerning Management of the Raw Wakame after Harvesting:

- a) To put the raw wakame into a container such as a basket or strainer in order to prevent impurities being mixed in. (Raw wakame should not be placed directly on the ground).
- b) In order to prevent the quality of the raw wakame from changing (becoming mouldy), attention must be paid to proper ventilation and to not allowing the wakame to become piled up.
- c) In order not to fade the colour of the wakame, direct sunshine must be avoided.

1.2.6 Quality of Packing:

At present, the main packing materials used are humidity-proof cellophane, polypropylene and polyethylene. In order to maintain the product, the packing materials should be of a suitable quality.

Particular Considerations are as follows:

1. Ability of the packing materials to act as a barrier against moisture and oxygen.
2. Ability of the packing materials to act as a barrier against light.
3. Strength of the packing materials.
4. Ability of the packing materials to be printed upon.
5. Packing materials must be sufficiently strong to withstand stamping and sealing.
6. Material used must be suitable for packing.

1.2.7 Receiving the Packing Material at the Factory:

Before it reaches the acceptance standards of the factory, the packing manufacturer is made to submit a quality certificate concerning various characteristics of the packing material. The standard and the quality of these packing materials should meet the present conditions.

Demonstrated quality standards are enacted by the Law. Regarding quality standards and methods, manufacturers are obliged to follow the Law; therefore

printing displayed on the packing material should collate with the standards and its suitability as a packing material must be confirmed.

1.2.8 Storage of the Packing Materials:

In order to prevent changes in the quality of the materials, the place of storage should be one where control of insects and a means of preventing blemishing and corruption of materials has been established, as well as being a place where high temperature and humidity is avoided.

In the storage place, management is necessary to record the date of arrival of packing materials, brand name and grade and to maintain the "first in, first out" principle.

Various characteristics of different packaging materials are described in diagram

3.1.

Remarks:	+++	outstanding
	++	excellent
	+	good
	±	average
	-	inferior
	/	can't be used

"K" Polyvinylidene chloride

CPP Pre-stretched polypropylene

DPP Double axes stretchable propylene

KOP Double axes stretchable propylene coated with poly vinylidene chloride.

DIAGRAM 3.1: VARIOUS CHARACTERISTICS OF PACKAGING MATERIALS

Characteristics		Barrier Quality		Strength				Functional Factors		
		Steam Permeability	Gas Permeability	General Strength	Firmness	Characters at low temperature	Characters at boiling point	Transparency Clarity	Characters of the packing machine	Characters of processing
Cellophane	Ordinary cellophane	/	±	±	++	-	/	++	+++	+++
	Moisture-proof cellophane	±	+	±	++	-	/	++	+	+
	"K" cellophane	++	++	±	++	-	-	++	++	++
Polypropylene	cpp	-	-	+	±	-	++	+	-	±
	opp	++	-	+	+	+	++	++	±	++
	kop (boiling type)	+++	++	+	+	+	++	++	±	++
	kop (non-boiling type)	+++	++	+	+	+	/	++	±	++
	heat sealing oop	++	-	+	+	+	/	+	±	++
Polyester	polyester	-	±	+	++	±	+++	++	++	++
	"k" coat polyester	++	++	+	++	±	++	++	++	++
Nylon 6	double-axis stretchable	±	-	+++	+	+++	+++	++	++	++
	"k" coated d-a stretchable	-	++	+++	+	+++	++	++	++	++
	cast	±	+	+++	+	+++	+++	+	±	±
	"k" coated cast	-	++	+++	+	+++	++	+	++	+
Nylon 66	pre-stretched	±	-	+++	++	+++	+++	+	++	+
Vinylon	"k" coated d-a stretchable	+	+++	+	++	+	/	++	+	+
	evaal	±	+++	±	+	±	/	+	±	-

DIAGRAM 3.2: VARIOUS CHARACTERISTICS OF PACKAGING MATERIALS (2)

POINTS MATERIALS		strength of the packaging bags	resistance to pin holes	firmness	sealing strength	low temperature sealing strength	high temperature sealing strength	sealing in of impurities	transparency	preventing static electricity	slipperiness of the material	resistance to curling	oil resistance	cold resistance	heat resistance	automatic packaging machine suitability
		EVA (Ethylene acetic acid vinyl polymer)		++	++	-	++	++	++	++	+	/	-	±	+	++
IONOMER (Ionic polyethylene)		+++	+++	±	+++	+++	+++	+++	±	/	-	+	±	++	-	+++
LDPE (low density polyethylene)		±	±	+	±	±	+	±	+	-	+	±	+	++	+	±
LLDPE (low density, low pressure polyethylene)		+++	+++	+	+++	+++	+++	+++	±	/	-	±	+	+++	±	+++
HDPE (middle & high density polyethylene)		+	+	++	±	-	±	+	-	-	±	++	++	±	±	+
CPP (polypropylene)	low temperature sealing type	±	±	±	±	+	++	-	±	+	+++	±	++	-	±	+++
	general type	+	+	++	+	-	±	-	±	+	+++	±	++	-	±	±
	single axis stretchable type	+	+	+++	±	+	±	-	+	+	+	+	++	-	±	±
	boiling type	+	+	++	±	-	±	-	+	/	+	++	++	+	±	+
	retort type (up to 120°C)	±	±	±	++	-	±	-	-	/	+	+++	++	+	++	±
	high retort type (up to 140°C)	±	±	±	++	-	±	-	-	/	+	+++	++	+	++	+

DIAGRAM 4: AN EXAMPLE OF THE ACCEPTABLE STANDARDS FOR POLYPROPYLENE PACKAGING MATERIALS

		ITEM	STANDARD
MATERIAL	Material test	Cadium	under 100 ppm
		Zinc	under 100 ppm
	Effluent test	heavy metal	under 1 ppm
		quantity of KMnO ₄ consumed	under 10 ppm
		amount of residue after evaporation	under 30 ppm
	Degree of oxygen transmission		500 cc/cm ³ - 24 hr
	Degree of humidity transmission		5g/m ² - 24 hr
PRESENTING CONDITION	Appearance	pin-holes	none
		scratches, stains	none
		sealing part	good sealing
	Indications	appropriate labelling	should adhere to standard
		shearing/slipping in printing	should not occur

REMARKS: The standards for the material test and the effluent test are taken from the food/hygiene container standard.

1.3 Pre-treatment of the Raw Wakame:

1.3.1 Purpose of pre-treatment:

Cleaning and drainage of the raw wakame:

Cleaning should be carried out to remove dirt stains, impurities and foreign matter (such as earth and sand, various seaweed, diatomaceae, shrimp shells, water fleas (*Daphnia Pulex*) and so on). There are some harvesting areas where cleaning is done offshore by harvesters who have been instructed in the washing methods.

The wakame should be drained for the purpose of enhancing the following "half-drying" process:

1.3.2 Cleaning:

a) Water:

As much as possible, an abundant quantity of clean sea water should be used for cleaning.

b) Cleaning Method:

Cleaning is usually done using sea water, however this can cause drying out of the raw wakame and salt precipitation over the surface of the raw wakame body. In order to prevent this, there are cases where washing may be done in fresh water.

Points to consider when cleaning raw wakame in fresh water:

When cleaning in fresh water, one should take into consideration the importance of the necessity of very quick treatment ie: dipping in fresh water for a short time only as the raw wakame may become damaged during or after drying if the cleaning time is prolonged.

1.3.3 Removal of Stems and Impurities from the Raw Wakame:

Stems should be cut directly under the body of the leaves. All leaves which are extremely dirty, covered with impurities, withered or eaten should be removed. Dirt and impurities will stick more to the body of the leaves after the drying treatment and it becomes very difficult to remove at this stage. Forcible removal of dirt and impurities will cause leaf damage and will lead to a decline in the quality and the product yield rate. Therefore it is essential to remove impurities as much as possible before drying. Particular care should be taken not to damage or to over wash the leaves.

1.3.4 Removal Method of Diatomaceae:

In the Sanriku Coastal District (Northern Pacific side of Honshu), which is the area of production of dried wakame, any leaves to which diatomaceae is adhered are removed. However, in Hokkaido, Dorsan Wakame (a product of Hokkaido) is treated with Magnesium Carbonate which effectively removes diatomaceae from the leaves.

a) Removal Method:

0.1 - 1% of Magnesium Carbonate is added to seawater which is 2-3 times the weight of the wakame. The wakame leaves should be immersed in the supernatant fluid (of the above). If this agitated for over 10 minutes, the diatomaceae will be effectively removed.

After removal of the diatomaceae, and after washing the wakame 2-3 times in clean seawater, the wakame should be cleaned and dried. Moreover, this method could be applied to the removal of diatomaceae from dried wakame, but compared to the time taken to treat raw wakame, this method is not as effective for dried wakame.

b) Yield Rate:

The yield rate of wakame which has been influenced by diatomaceae is shown in diagram 5. The yield rate of wakame products which have not been treated for removal of diatomaceae is 14%. Compared to this, the yield rate of wakame which has been treated in the 1% Magnesium Carbonate Supernatant liquid for 10-20 minutes is 13.25%. This is equal to 95% of non-treated products. Products which have been treated for 30-60 minutes have a yield rate of 15% (equal to 95% of non-treated products).

The yield rate of wakame treated by magnesium is only fractionally less than that which has not been treated. Compared to cases where leaves which have diatomaceae attached have been discarded, the Magnesium Carbonate treatment can be seen to be effective in raising the yield rate of raw wakame.

Diagram 5 The Yield Rate of Dried Wakame Products:

Types of Treatment:	Yield Rate (%):
Products which have not been treated with Magnesium Carbonate	14.00
Diatomaceae Removal Treatment:	
10 minutes	13.25
20 minutes	13.25
30 minutes	13.00
60 minutes	13.00

Liquid used to remove diatomaceae:

Supernatant liquid is made mixing water to which 3% salt has been added and 1% Magnesium Carbonate.

Treatment: Immersion Agitation

60 minute treatment: 3 short agitations throughout the immersion time.

Drainage:

Drainage is done using a basket and sieve. If wakame is left in the basket/sieve for a long period after drainage, the work of self digestive enzymes causes the wakame to give off its own peculiar smell, as well as a loss of flavour and lustre and softening of the leaves. It is therefore desirable to go on to the next stage as soon as possible.

1.4 Drying**1.4.1 Purpose:**

Drying is done for the purpose of preservation of the wakame by reducing the water content, suppressing the activity of the self-digestive enzymes, and preventing the growth of germs. This process will have a significant effect upon the quality of the product therefore special attention is necessary regarding this method, the drying ability of the wakame and the temperature and humidity used.

1.4.2 Drying Method:

a) Sun Drying Method

The utilisation of nature - the sun's heat, wind and so on is the most economic method of drying. However, a good environment and an area with an established amount of space is necessary and as well as this, this method is influenced by the weather. There are some drawbacks with this method. e.g. If the wakame is exposed for long periods in direct sunshine, the ultra violet rays fades its colour and changes the Chlorophyll and Fuco Acid (Fucoase) within the body of the wakame.

b) Machine Drying

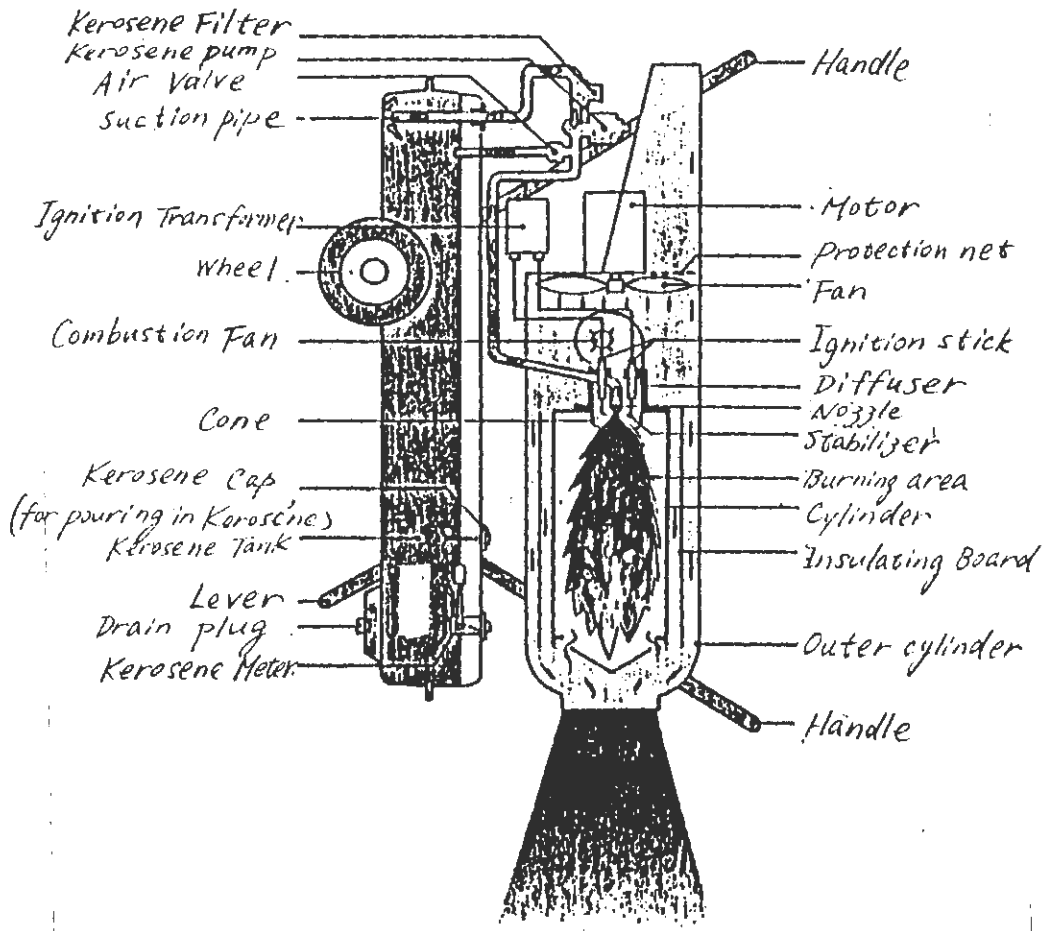
Compared with the sun-drying method, the machine drying method has less drawbacks and shows less deterioration in quality due to colour fading. As well as this, there is the advantage of being able to work regardless of the weather in artificially set up drying conditions. On the other hand, machine drying has drawbacks like being very expensive and not being economical. Because of this, in the Sanriku Coastal District, there are many instances where both methods are used simultaneously; the sun-drying method is used until the wakame is 30-70% dry and it is then machine dried.

c) There is no special drying machine or drying room exclusive to wakame but each district uses machines they have invented themselves. For example, in the Sanriku Coastal District, simple drying rooms are normally used. These are 4.5 m² with a window in each wall; the windows are 60 cm x 40 cm and there are 1 or 2 electric fans on the ceiling. In other districts, a device which was shown in "Photo-Gravure" (magazine) is being used. The device - an iron frame - is set up in the drying room. The wakame hangs from this and it dries by the rotation of the device. Recently however, kerosene spray burners are commonly used as the heat source for the drying room. An example of this is shown in Diagram 7.

DIAGRAM 6: THE QUALITY OF THE FINISHED PRODUCT DEPENDS UPON THE MANUFACTURING METHOD.

Manufacturing method	Absorption percentage of light at 663mu	Crude fat (%)	Crude protein (%)	Ash (%)			Appearance of the finished product
				Insoluble Ash	Soluble Ash	Total Ash	
Finished product has been machined dried at 50°C after being blanched for 1 minute at 85°C	0.850	2.12	17.66	6.05	9.83	15.88	Blackish green in colour; body of the leaves is springy and resilient, undamaged by machine drying. No fragrance.
Sun - dried finished product after being blanched for 1 minute at 85 °C	0.450	1.77	18.22	7.43	8.35	15.78	Dark green in colour; body of the leaves is resilient, undamaged by machine drying. No fragrance.
Finished product which has been washed in sea water and machine dried at 50°C	0.470	1.38	13.01	5.99	31.14	37.13	Blackish brown colour; not resilient, leaves easily breakable by machine drying. Has fragrance of Wakame.
Sun - dried finished product which has been washed in sea water	0.260	1.02	14.52	5.95	29.31	35.26	Black/dark brown in colour, tip of the leaves is partly brown/dark brown; the thin part of leaves is a faded yellow-green colour. The leaves are fragrant but not resilient and are easily broken.
Finished product which has been washed in tap water and machine dried at 50°C	0.560	2.04	17.81	5.99	19.33	25.32	Greenish dark brown colour; has some resilience; not many leaves have been damaged by machine drying. Has fragrance of Wakame.
Sun - dried finished product which has been washed in tap water	0.290	0.68	16.88	5.77	18.09	23.86	Greenish dark brown is the main colour of the body; the tip of the leaves is either dark brown or yellowish green. There is some resilience and not many of these leaves are broken by machine drying. Has fragrance of Wakame.

Diagram 7: Example of Spray Burner
 (High-pressure Spray Burner)



Source material:

From the Orion Machine Co., Ltd. Catalogue

1.4.3 Semi-drying process after drainage:

This process is done for the purpose of preventing degradation of the flavour and lustre as well as the softness of the wakame leaves which makes the next step (shaping and sorting of the wakame) easier.

a) Sun-drying

Work should be done paying special attention to the following:

- i) Choose an area which is well ventilated. The roots of the wakame must hang from pegs which have been clipped onto a straw rope. The rope is then draped over nails which have been attached to a board. To ensure even drying, the wakame must be dried in a well ventilated area with adequate space between. The drying of the mid-rib of the wakame takes a long time when compared with the drying of the leaves, therefore they should be turned over at set intervals.
- ii) The drying process should be stopped when the wakame is about 70% dry (water content is 25-30 %). During the drying process, the removal of withered leaves, impurities and the mid-rib (or cutting it into 2 halves) is done.
- iii) If drying takes a long time due to bad weather condition, naturally the result is poor and the body leaves of the wakame become soft and mouldy. Therefore adequate attention must be given to the weather. If it rains during the drying process, the quality of the wakame declines dramatically and so therefore at night time if there is concern that it may rain it should be stored inside temporarily.

b) Machine Drying:

Work should be done paying careful attention to the following:

- i) In cases where raw wakame has been harvested directly from the sea, it should be dried gently by fan at a temperature of 30° - 40°C. Furthermore, in order to be dried evenly, it is necessary to ensure that the wakame is spread out and not overlapping.
- ii) In cases where the raw wakame has been partially sun-dried (more than 30% dried) it is then dried at 50° - 60°C by machine. If wakame is dried using a high temperature from the beginning, the drying speed is fast but the colour and flavour will deteriorate. Only the leaves will be dried quickly but the thick midrib parts will not dry completely and this causes uneven drying. In cases where the thick midrib parts are not completely dried, after shipment, the surface of the wakame will whiten due to salt precipitation. This brings about a lowering in the value of the goods. Therefore, consequently, adequate management of the

drying temperature, humidity and timing is important when machine drying.

- iii) In order to suppress the enzyme which caused quality deterioration during the semi-drying process, there are instances in which drying is done in one short burst until this enzyme is killed. Wakame dried in this way is very fragile to touch. If the fan is increased the wakame leaves will brush against each other so care must be taken as the leaves can become damaged. Furthermore, when the wakame is removed from the dryer, the machine window must be left open to absorb any humidity naturally (moisture content 25-30%). This is the stage at which it is safe from any damage.

1.4.4 Drying after Trimming and Sorting the Wakame Leaves:

This is the final stage of drying. Either by sun-drying or machine drying, the moisture content of the wakame drops to 15-18%. Overdrying in this process might disrupt the process of selection, weighing, packaging or be disruptive at the distribution stage. Furthermore, incomplete drying will cause mould and rot, therefore adequate management is necessary for the measurement of moisture content.

1.4.5 Product Quality of Sun-dried and Machine Dried Wakame:

The influence of sun-drying and machine drying on the quality of the product is shown in Diagram 6.

Lustre and colour-tone are important factors which act as a standard for judging the quality of the product. In particular, chlorophyll, which is a green pigment, is a conclusive factor. Machine drying causes less of a decrease in chlorophyll than sun-drying. In machine drying there is twice the amount of residual chlorophyll content than in sun-drying. Furthermore, hardly any difference can be seen between sun-drying and machine drying in regards to other chemical constituents.

1.5 Arrangement/Sorting

1.5.1 Purpose of Sorting:

In order to raise the value of the finished product, preparations are made for the sorting, trimming and selection of the leaves; removal of defective leaves (withered, red, cut, blight-ridden, insect-ridden) and removal of the midrib of the leaves. Adjustment of the temperature of the dark room is also done.

1.5.2. Trimming:

Pay attention to the following when doing the above.

- a) Wakame which has been excessively dried (moisture content less than 18%) is easily damaged so a moisture content of around 25-30% should be returned to the leaves by means of spraying, so that work on the leaves can be resumed.
- b) The stem should be removed by scissors and in order not to harm the body of the leaves the thick midrib should be removed by cutting away both sides using a knife, gimlet or nail. As for the thin midrib, cut down the centre of the narrow midrib to make two separate halves.
- c) A mixture of defective leaves and foreign objects greatly devalues the product, so these should be removed completely. Impurities too should be removed as much as possible.
- d) To ensure that preparation is sufficient, if possible, a trained person is desirable to carry out this specific work. After the above mentioned process, drying after trimming and adjusting (1.4 (4)) is done before going on to the next process.

1.5.3. Selection:

According to various companies selection standards, the product is sorted by means of grading and branding, and the final removal of defective leaves. For your reference, the examination standard of Miyagi-Ken Fishery Co-operative Association is shown in Diagram 7.

1.5.4 Dark Room at Room Temperature:

After the wakame has been selected, it is wrapped in a straw mat or vinyl mat or placed in a wooden box and left in a dark room at room temperature. The aim is to achieve a balance in the moisture of the body of the leaves.

The time needed for this dark-room treatment differs, depending upon the dryness of the finished product, normally 3-7 days. After this treatment the wakame should be supple to the extent that it does not break easily, even when it is placed in boxes and therefore bent over.

Diagram 7 Examination Standards of Dried Wakame

1. Miyagi-Ken Fishery Co-operative Association's examination of Dried Wakame (cultured and natural) based upon the undermentioned standard.
2. Name of the product "Cultured", "Natural" and "Contents" should be clearly written in an easily identifiable place on the product.
3. Judging standards of the Grades of Dried Wakame:

<p>1ST GRADE QUALITY</p> <ol style="list-style-type: none"> 1. Raw Wakame in good condition has no foreign matter or Diatomaceae attached and there is no damage by noxious insects. 2. Leaf quality is soft and has strong resilience. 3. There is no discolouration of wakame caused by rod/pole/rope/grass/rock used in drying process. 4. No red or withered leaves. 5. No mould or attachment of white powder. 6. There is no change of quality throughout the drying process. <p>Lustre</p> <ol style="list-style-type: none"> 1. Should be dark brown black or dark green in colour and have an even lustre. 2. There should be no colour change throughout the manufacturing process. <p>Fragrance</p> <ol style="list-style-type: none"> 1. Has a good, distinctive fragrance. 2. There are no foreign odours such as a musty or mouldy smell. <p>Appearance</p> <ol style="list-style-type: none"> 1. Good shrinkage of leaves. Has the small leaves of non-cultivated (natural) wakame. 2. Roots of the wakame should be cut directly below the bottom leaves. 3. Wide midrib is removed by making 3 incisions at the sides and centre of the midrib. 4. Only leaves in good condition have been selected. 5. No shorter leaves are present. <p>Degree of Dryness</p> <ol style="list-style-type: none"> 1. Moisture content less than 22%. <p>Impurities</p> <ol style="list-style-type: none"> 1. No earth, sand or impurities present, however, in cases where wakame has dried on the sand, a 5% mixture of sand is acceptable. <p>Packaging</p> <ol style="list-style-type: none"> 1. The products should be of an even quality and be bound together in small bundles and packed into a box up to 10 kg at a time. 2. The bundles should be packed into a vinyl bag which is then placed inside a box made of cardboard carton. 3. For the outer wrapping of the box, use paper and a vinyl tape and wrap in the normal way.
--

1.5.5 Judgement Standards of the Grade of Short-Length Wakame 30-50 cm):

Wakame that is less than 30-50 cm in length should be graded according to the above mentioned standards, packaged separately in cardboard cartons and labelled clearly.

2ND GRADE**Quality**

1. Raw Wakame is mainly in good condition. Has no foreign matter or Diatomaceae attached and there is damage by noxious insect.
2. Leaf quality is slightly thick and resilience is slightly weak.
3. There is no discolouration of wakame caused by rod/pole/rope/grass/rock used in drying process.
4. There are very few red or withered leaves.
5. Very small amount of white powder and mould.
6. Very slight change in quality throughout the drying process and preservation process.

Lustre

1. Although upon superficial examination the colour appears dark brown/black or green, there has been a colour change to brown or green upon closer examination.
2. There is very little colour change during the manufacturing process.

Fragrance

1. Wakame have an inoffensive smell.
2. There are very few foreign colours such as a musty or mouldy smell.

Appearance

1. Normal shrinkage of leaves. Has the medium sized leaves of non-cultivated (natural) wakame.
2. Roots of the wakame should be cut directly below the bottom leaves.
3. Wide midrib is removed by making 3 incisions at the sides and centre of the midrib.
4. Only leaves in good condition have been selected.
5. No shorter leaves are present.

Degree of Dryness

1. Moisture content less than 22%.

Impurities

1. No earth, sand or impurities present. However, in cases where wakame has been dried on the sand, a 5% mixture of sand is acceptable.

Packaging

1. The product should be of an even quality and is bound together in small bundles and packed into a box up to 10 kg at a time.
2. The bundles should be packed into a vinyl bag which is then placed inside a box, use paper and a vinyl tape and wrap in the normal way.

3RD GRADE**Quality**

1. Normal condition of the raw wakame is that Diatomaceae, other foreign matter and many harmful, noxious insects are attached to it.
2. Leaf quality is hard and thick and of a weaker resilience.
3. There is a normal amount of rod, rope, grass and rock discolouration.
4. Some red and wither leaves present.
5. There is some attachment of mould and white powder.
6. Quality of the raw wakame changes quite a lot during the drying and preservation process.
7. Degree of damage by sea pollution is not great.

Lustre

1. Yellow/green or light brown in colour or with some small degree of yellow-brown.
2. Colour changes throughout the manufacturing process are not extreme.

Fragrance

1. Some fragrance.
2. Weak musty, mouldy smell.

Appearance

1. Leaf shrinkage is poor. Large leaves of non-cultivated wakame have tendency not to shrink and they remain loose.
- 2 & 3 Same as for 1st Grade.
4. Poor selection and arrangement of leaves.
5. Only a few short leaves.

4TH GRADE**Quality**

1. Quality of the wakame is poor - damaged by noxious insects and by attachment of foreign matter.
2. Leaf quality is thick, hard and resilience is extremely weak.
3. There is much rod, rope, grass and rock discolouration.
4. Many red, withered leaves evident.
5. Attachment of much mould and white powder to the wakame.
6. Extreme quality change during the process of drying and preservation.
7. Extremely damaged by pollution.

Lustre

1. Light brown or brown colour with uneven tones and discolouration is extreme.
2. Colour changes throughout manufacturing process are extreme.

Fragrance

- 1 & 2 Very little fragrance with some foreign colours ie. musty and mouldy smell.

Appearance

1. Leaf shrinkage is very poor
- 2 & 3 Wakame leaf roots and stems have been poorly cut.
4. Very poor leaf selection and arrangement.
5. Many short leaves.

Degree of Dryness

Same as for 1st Grade.

Impurities

Same as for 1st Grade.

Packaging

Same as for 1st Grade.

The 5th Grade: All items: Less than 4th Grade.

1.6 Weighing and Packaging

1.6.1 Weighing:

Ensure that the weighing machine is checked before use and that it is cleaned after use.

Take into consideration a decrease in weight of the finished product during the manufacturing process. See the following diagram:

Diagram 8 Net Weight Standard (example)

Net weight written on label	Estimated weight loss plus the labelled net weight
100 g	102 ± 2 g

1.6.2. Packaging:

Packaging of Dried Wakame:

Heat sealing is desirable for the maintenance of quality of the wakame.

- a) Packing materials should be checked to ensure they are not damaged.
- b) The packing machine (heat sealer) should be checked before use to ensure it is set as the correct temperature.
- c) After heat sealing the bags, check to see that they have been sealed adequately.

1.7 Product Inspection Standards

Refer to Diagram 9.

1.7.1 Preservation Test:

There are two methods of testing the expiry date of the flavour of dried wakame. The preservation test is done to judge the expiry date of the wakame. It is desirable that both the following tests be carried out on the dried wakame. The two methods are:

- a) The constant temperature test in a high temperature area.
- b) Testing in room temperature.

1.8 Storage and Shipment of the Product

1.8.1 Make sure the wakame product is kept refrigerated at a constant temperature in a clean refrigerator. Periodical checks are necessary to prevent collection of mould, moisture in the product and to maintain quality.

1.8.2 Shipment:

Ensure the product does not become wet at any time, if it is raining at the time of shipment.

ITEM		STANDARD
PACKAGING	Sealing	Seal is in good condition. Contents of package have not been caught up in seal.
	Appearance	No pin-holes; dirt or damage
	Labelling	Expiry date and DPI stamp are clear. Correct labelling and attachment of label to package.
Net Weight		Should coincide with quantity marked on label.
QUALITY	Body quality	In good condition; resilient when returned to water.
	Lustre	Wakame's own special lustre; no withered leaves.
	Flavour	Wakame's own special flavour; no musty smells.
	Appearance	Midrib has been removed. Hardly any small leaves. No leaves infested with small insects.
Mould		None
Impurities		Hardly any
Foreign Matter		None
Moisture Content		16 ± 2%

2. PROCESSING AT THE PLACE OF HARVEST OF THE RAW WAKAME (BLANCHED: SALTED WAKAME)

2.1 The Manufacturing Plan for Blanched-Salted Wakame is the same as for dried Wakame

(1. 1.1)

2.2 Receiving and Storage of Equipment and Raw Materials

2.2.1 Quality of the blanched-salted wakame, raw wakame which is of the same standard as set out in 1. 1.2 (i) should be used.

2.2.2 Receiving the raw wakame into the factory is also the same as in 1.1.2(ii).

Receiving salt into the factory: This should be carried out in accordance to the quality standards which are set out in Diagram 10.

2.2.3 Quality of the packing materials: plastic wrapping materials for inner use.

a) Use the same packing materials as set out in 1. 1.2 (iii).

b) Wooden Box (outer container)

Normally wooden boxes are used but try to avoid the woods that emit a strong odour such as pine. Polystyrene-foam and cardboard carton boxes may also be used.

2.2.4 Receiving packing materials into the factory:

Do the same as for 1. 1.2 (iv).

2.2.5 Storage of salt:

In order to prevent quality change by absorption of moisture the salt should be placed on a raised wooden rack in a well ventilated place.

2.2.6 Storage of packing materials:

Storage of blanched-salted wakame is the same as for dried wakame. (1. 1.2 (v)).

2.3 Pre-Treatment:

Pre-treatment process is normally done by the wakame harvester, so it is sufficient just to check the degree of drainage before moving on to the next stage. The pre-treatment process is the same for blanched-salted wakame as it is for dried wakame ie. - both are pre-treated by the harvester.

DIAGRAM 10: SALT QUALITY STANDARD (FOR FISHERY PRODUCTS)

	Production Methods	NaCl	Size of Grains	Usage	Characteristics
Table Salt	By boiling concentrated seawater (ion exchange method)	over 99%	over 80% 590-149 microns	for fishery products	Has a wide variety of uses
General Household Salt	as above	over 95%	over 80% 590-149 microns	as above	This salt is typically used in industry. Purity of the salt is not necessarily required.
Pulverised Rock Salt	rock/sea-salt which has been pulverised	-	less than 15% are over 1190 microns. less than 40% pass through 500 microns.	as above	A pulverised rock/sea-salt.

2.4 Blanching

a) Purpose:

Chlorophyll contained in the raw wakame before it is cut (ie.- still living) is loosely connected with the protein known as Chloroprotein but by blanching, an oily substance in the cell is released and the body leaves change to green. Also by blanching, some enzymes will die which helps prevent the self digestion of alginic acid and chlorophyll.

b) Blanching Method:

i) Boiling tub:

Blanching should be done in either a single tub (batch tub) or a multi-tub (continuous boil).

In order to prevent uneven blanching, use an appropriate amount of water for the size of the tub. If using a single tub, the water must be agitated. The quantity of raw wakame to be immersed into a single tub, 3 kilo litres (2 x 1.5 x 1 metres) is 30-35 kg at a time.

ii) Water to be used:

The desirable water quality for factories which are situated inland and using underground water is a slightly alkaline hard water. Sea water used by factories situated near the sea should not contain any mud or waste water.

iii) Temperature and Time:

Short time high temperature treatment is desirable and it is necessary to maintain the temperature at over 85°C when immersing the raw wakame. The boiling standards are as follows:

Wakame which has been harvested early should be boiled for 30 seconds, wakame harvested in season boiled for 40 seconds and the thick bodied wakame harvested at the end of the season should be boiled for 50 seconds. Fixing the boiling times is determined by the greenness of the midrib of the wakame.

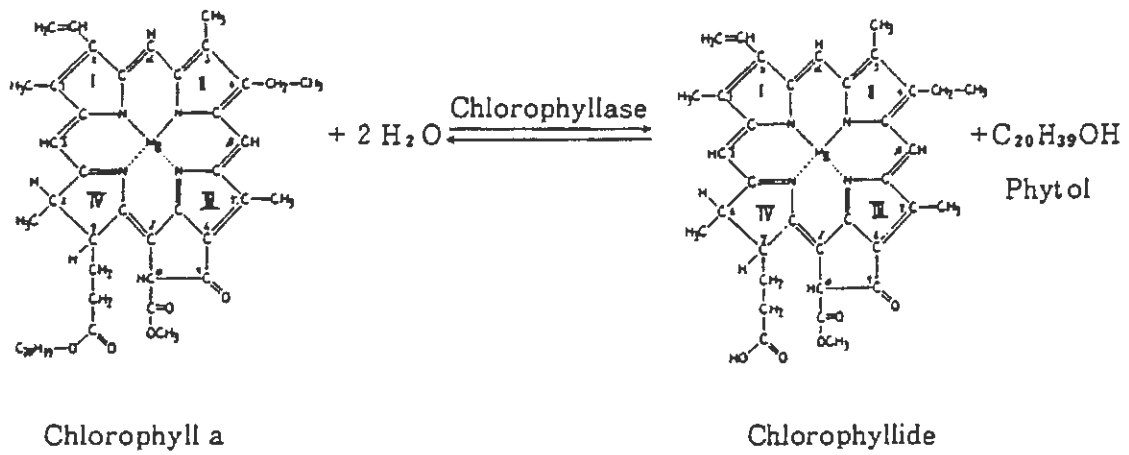
Wakame that has been insufficiently blanched has a black midrib when held up against the sun, or when the midrib is split down the centre it appears dark-brown. Also, enzymes in the wakame do not die and this causes the chlorophyll to self digest; phytol is released and becomes chlorophyllide and also alginic acid turns into a monomer and oligomer which causes softening of the body of the leaves.

Excessive blanching causes the magnesium in the polyfilin compound to be displaced by 2 hydrogen atoms and the chlorophyll to become phaeophyllin as well as colour fading of the wakame leaves.

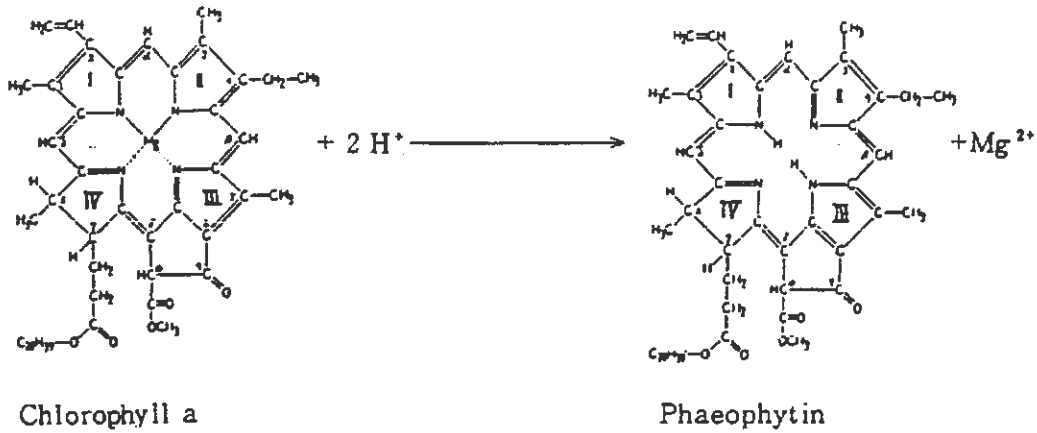
Test results (at the raw wakame harvesting site); temperature at the time of treatment; fridge preservation and room preservation according to

treatment temperature and length of time are as shown from Diagram 8-1 to 8-3.

From these test results, it can be seen that good results arise from a treatment temperature of over 70° and length of time under 60 seconds; although there may be big differences depending upon the wakames leaf quality.



参考※ 2



Wakame similar to Brown algae and the like contains Chl. C1, Chl. C2.

Chl. C1; IV - 7 : CH = CHCOOH
 IV - 7,8 : Double Linked

Chl. C2; IV - 7 : CH = CHCOOH
 IV - 7,8 : Double Linked
 II - 4 : CH = CH₂

DIAGRAM 8.1 Wakame from Japan Sea

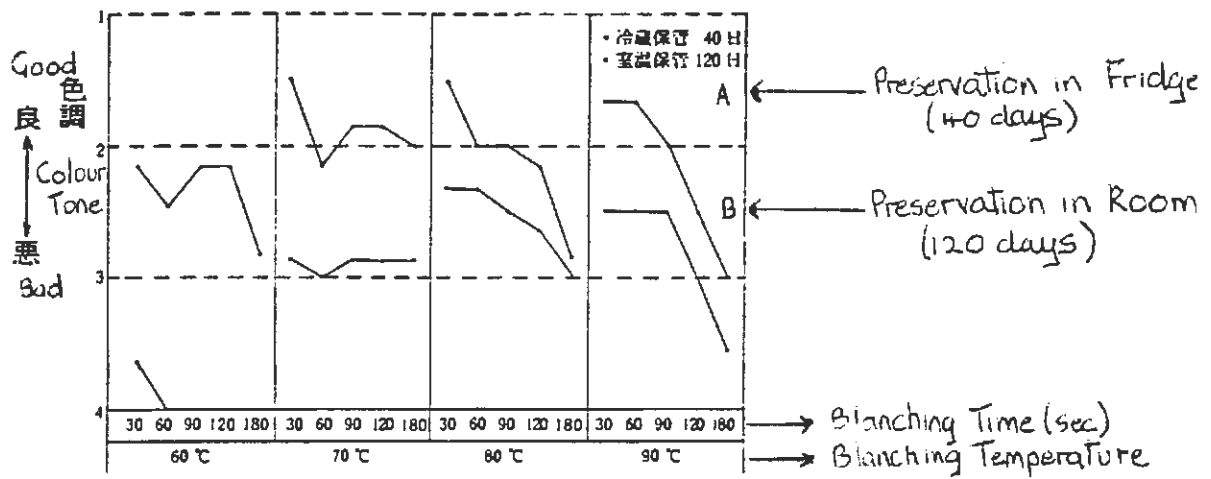


DIAGRAM 8.2 Wakame from Pacific Ocean

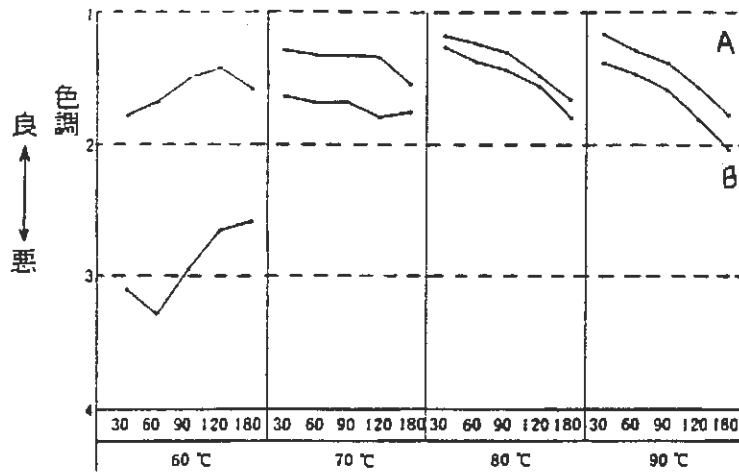
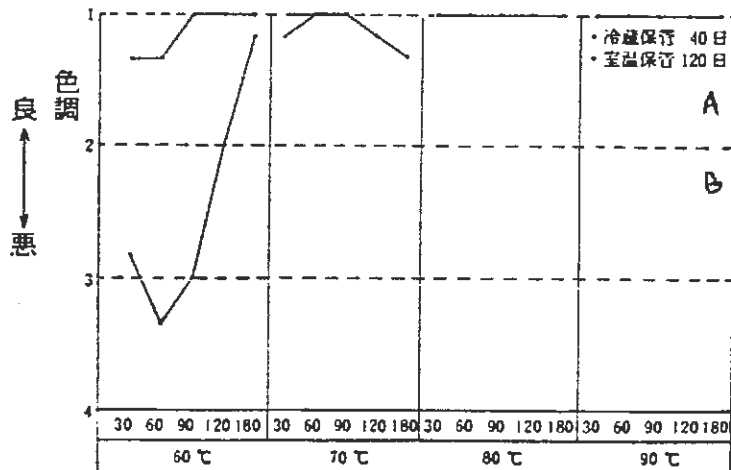


DIAGRAM 8 - 3 Results of Colour Test: (using Time and Temperature Treatment)

(Wakame from all fishing sites)

(Average quality wakame: averaged result over a period of time)



iv) Changing of the Boiling Water:

If boiling water is used for an extended period of time, the pH level drops. Compared with 1st blanched lot of wakame, the colour tone of wakame blanched in a later lot is inferior, so in order to maintain a pH of more than 6 in the boiling H₂O, in single-tubs, it is necessary to change to fresh boiling water with every treatment. For multi-tubs (contains boiling water) it is necessary to have a continual supply of fresh boiling water.

In some parts of Japan, scallop shells are immersed into the boiling water in order to prevent a drop in the pH level.

Test results of the changing pH level of boiling water is shown in Diagrams 9 - 1 and 9 - 2.

DIAGRAM 9.1 THE CHANGING PH OF BOILING WATER

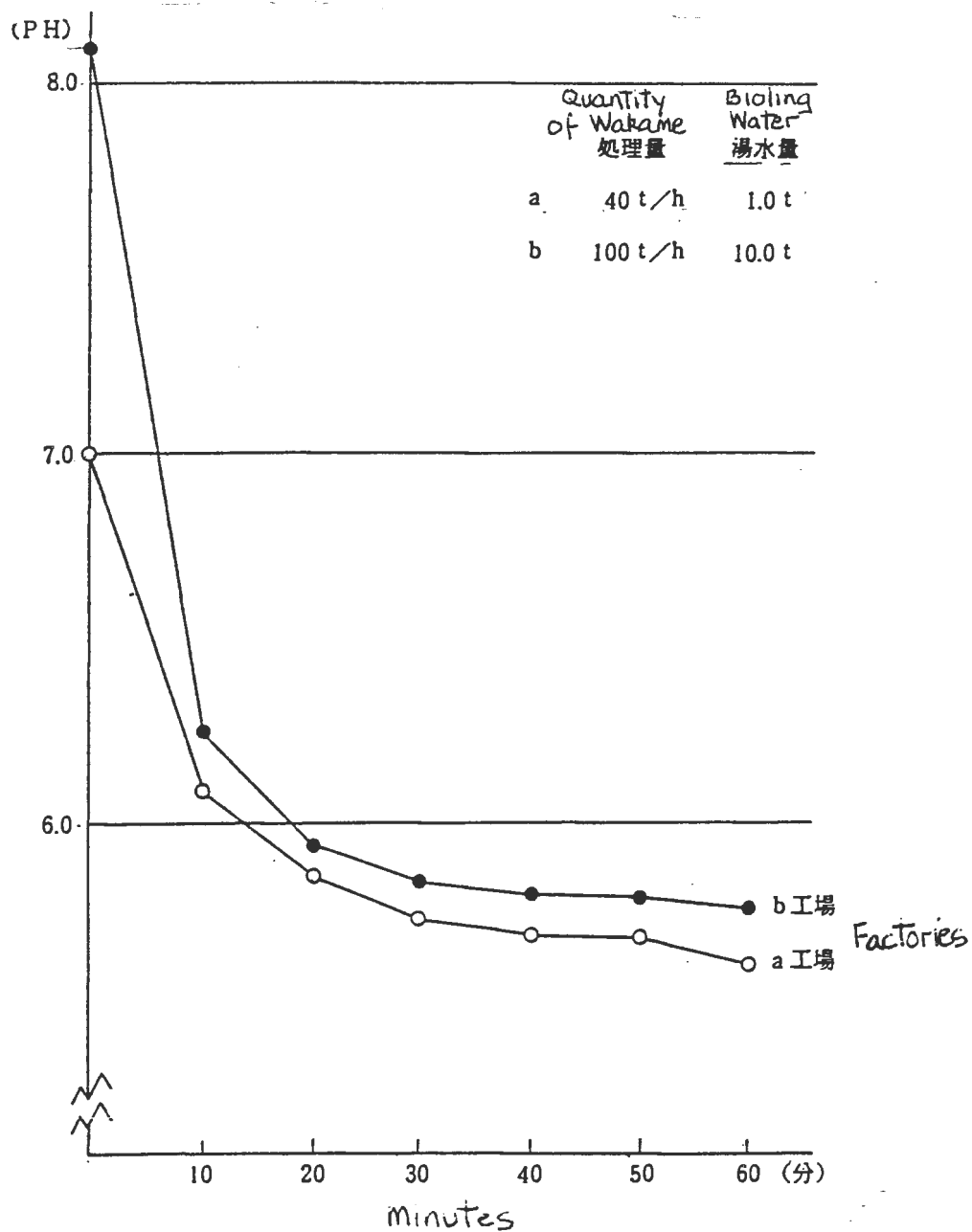
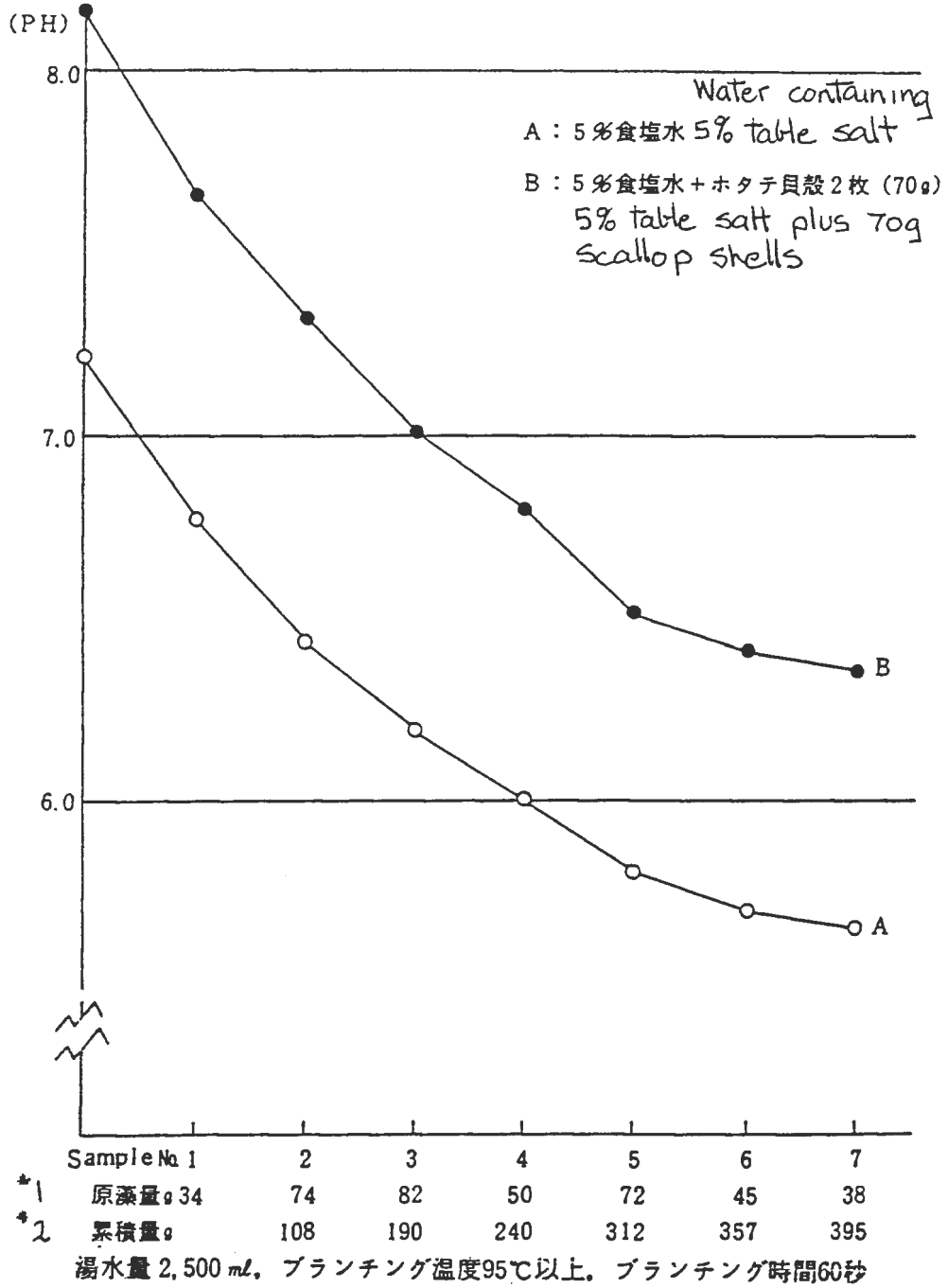


DIAGRAM 9.2 CHANGING THE PH OF BOILING WATER



*1 - quantity of raw wakame in grams

*2 - cumulative quantity of raw wakame in grams

2.5 Cooling and Drainage

2.5.1. Purpose:

Cooling rapidly stops the reaction of blanching, prevents colour fading and helps to stabilise the colour tone. Cooling under running water helps also to remove impurities, at the same time cleansing the wakame. Drainage is done to make the next stop in the process easier.

2.5.2. Method of Cooling and Drainage:

a) Cooling:

There are 2 types of cooling tub - single tub and continuous tub types. Both tub types use a lot of running water, cool down the body leaves of the wakame rapidly and wash away impurities and foreign matter. If cooling is not rapidly done or is insufficient this causes chlorophyll to change to phaeophytin which brings about colour fading.

b) Drainage:

Drainage should be done by using either a drainage basket (for 1.5 - 2 hours) or a roller style drainage machine.

2.6 Adding Salt

2.6.1 Purpose:

Adding salt increases the osmotic pressure which makes it an effective preservative.

2.6.2 Method of Rubbing Salt into Wakame:

Normally crushed salt or ordinary salt is used to sprinkle evenly over the body of the leaves. Salt must be rubbed well into the wakame. The quantity of added salt is normally 30-40% of the quantity of the wakame. Leaves which have been harvested early may be soft and in this case less salt should be added. It should be increased in proportion to the hardness of the body of the leaves. A cylinder shaped continuous style mixer is normally used to rub salt into the wakame.

2.6.3 Pickling in Salt:

After being rubbed with salt, the wakame is pickled for over 36 hours in a fibre reinforced plastic type tank or in a basic tank which consists of a wooden frame covered by a vinyl sheet. A sufficient quantity of water should be used so all the leaves are properly immersed. The concentration of salt in the water should be balanced and the Baume Hydrometer set at 20-25°C when dealing with salt water in tanks.

2.6.4 Cleaning by Agitation, Straining, Drainage of all Excess Water:

Wakame which has been through the pickling process, should be cleaned by agitation in the tank, then removed and placed into a drainage basket (colander) or sandbags to drain. After drainage, pile the baskets of wakame on top of each other. Place a heavy weight on top of this for approximately 24 hours to drain off excess water. Then squeeze the wakame hard between the hands until water oozes out between the fingers. At this stage, the salt content of the wakame should be 20-25%.

2.6.5 Storage of Wakame after Drainage:

In cases where the processing of wakame cannot be continued immediately after drainage, the wakame should be placed in a clean, well ventilated container such as a plastic basket and stored in the fridge at -5°C - -10°C . clearly label the wakame with harvest place and time and the quality of the goods.

2.7 **Arrangement of Leaves**

As for 1), 2 and 3 (see sorting/trimming of leaves)

2.7.1 Drainage:

Remove any salt crystals or salt attached to the body leaves and place the wakame in either a basket or sandbag. Then drain the wakame by using either a centrifugal hydrometer or by compression until the moisture content is 55-60%.

2.8 **Weighing and Packaging**

2.8.1 Weighing:

See (1. 1.6)

*A high salt resistance weighing machine is desirable when weighing wakame.

2.8.2 Packaging:

- a) After weighing the leaves, place them in blue high-pressure polyethylene bags and then into wooden boxes.
- b) When packing into the blue polyethylene bags, try to get rid of as much air as possible. Simply fold the opening of the bags over. Do not use any fastenings, clasps and so on.

2.8.3 Wooden Boxes:

Clearly label the boxes with harvesting place harvesting time, manufacturing date, brand and grade.

2.9 Inspection of the Product

2.9.1 See (1. 1.7)

2.9.2 Product Inspection Standard is as shown in Diagrams 11-1, 11-2 and 12.

2.9.3 Product inspection should be carried out using the fire senses to observe quality, mould, impurities, foreign matter. Moisture should be measured using an infra-red moisture gauge and the salt content is measured using a Baume Hydrometer. The measurement method of moisture and salt content is shown in Diagram 13.

2.10 Storage and Shipment of the Product

2.10.1 See (1. 1.8)

Compared with dried wakame, blanched wakame is very easily affected by temperature and light, therefore particular attention should be given to this in regard to storage and shipment.

2.10.2 See P. 40 ?

2.10.3 A storage temperature of 15-20°C is desirable.

Diagram 11-1 Examination of the Grade and Standard of Blanched Salted Wakame that has had midrib removed

Both cultivated and natural wakame are based upon this standard.

(Based upon Iwate-Ken prefecture standards for 1982)

	1ST GRADE
Quality	<ol style="list-style-type: none"> 1. The raw wakame is in a good condition; has no foreign bodies or Diatomaceae attached. There is no damage by noxious insects. 2. Leaf quality is soft and has strong resilience. 3. No red or withered leaves.
Lustre	1. Bright green colour with even lustre.
Flavour	1 & 2 See Diagram 7 (ie. exactly same)
Appearance	<ol style="list-style-type: none"> 1. Leaf shrinkage is good. Leaves are small. 2. Roots of the wakame have been completely removed. 3. Midrib of the wakame have been completely removed. 4. Body length of the wakame should be over 50 cm. (Miyagi-Ken prefecture standard states that body length of wakame should be over 60 cm) 5. No torn scraps of wakame leaves should be mixed in.
Moisture and salt content	<ol style="list-style-type: none"> 1. The moisture content should be below 60%. 2. The salt content should be below 40%. 3. Salt has been washed off thoroughly from the body surface.
Impurities	1. No foreign matter present.

	2ND GRADE
Quality	<ol style="list-style-type: none"> 1. The raw wakame is in good condition. Attachment foreign matter is very rare. 2. Leaf quality is slightly thick and resilience is slightly weak.
Lustre	1. Bright green colour tone is not even over body of the leaves and lustre is inferior.
Flavour	1 & 2 See Diagram 7 (ie. exactly same)
Appearance	1. Leaf shrinkage is average and generally this grade is not up to 1st grade standards.
Moisture and salt content	<ol style="list-style-type: none"> 1 & 2 Same as 1st grade in this diagram. 3. Some salt remains on the body surface of the wakame.
Impurities	1. No foreign matter present.

	3RD STAGE
Quality	1. The raw wakame is in average condition and there is a small amount of attachment of Diatomaceae and foreign matter.
Lustre	1. Not bright green and evidence of a minor degree of yellow/brown colour.
Flavour	1. Has less flavour and generally does not meet any of the 2nd grade standards.
Appearance	1. Leaf shrinkage is poor and generally 3rd grade does not meet 2nd grade standards.
Moisture and salt content	<ol style="list-style-type: none"> 1 & 2 Same as for 1st Grade of this diagram. 3. Same as for 2nd Grade of this diagram.
Impurities	1. Some foreign matter present.

Remarks:

Short length wakame which is over 20 cm and under 50 cm should be packaged separately from the average length wakame. It should be placed in a container and labelled "Short Wakame".

Diagram 11-2 (Based upon Iwate-Ken prefecture standards for 1982.)

Examination of the Grade and Standard of Blanched Salted Wakame that has not had midrib removed. Both cultivated and natural wakame are based upon this standard.

All standards are the same as for Diagram 11-1 except that the midrib is still intact.

The standards for Iwate prefecture state that leaf length should be over 50 cm.

The standards for Miyage prefecture state that leaf length should be over 60 cm.

Diagram 13 Measuring method of Moisture and Salt content in Wakame

MEASURING METHOD	
Moisture	<p>1. Preparation of Testing Materials</p> <p>a) <u>Packet of wakame over 1 kg:</u> A packet of wakame (approximate 1 kg) should be divided into 4 quarters. 100 g of wakame should then be removed from each quarter and this 400 g mixed together. Place the mixed wakame on a sheet of aluminium foil and sprinkle with table salt. Divide the wakame in half, leave one half as it is and shake the excess salt off the remaining half.</p> <p>b) <u>Packet of wakame less than 1 kg:</u> After measuring the contents, divide the wakame in half, sprinkle with salt and leave half as it is and shake the excess salt off the other half.</p> <p>2. Measuring the moisture content: Take 100 g of the body leaves from which excess salt has been shaken and shred it finely then stir well. Remove 20 g of the shredded wakame and dry it at 105°C for 10-20 minutes before measuring the moisture content with an infra-red moisture gauge. The difference between the weight of the wakame before and after it is dried becomes the percentage of moisture content in the wakame after the original amount of wakame (ie. 20 g) is divided by the difference between the weight of the wakame before and after it is dried.</p>
Salt content percentage	<p>1. Preparation of Testing Materials: Same as for measurement of moisture.</p> <p>2. Measurement of Specific Gravity: Take 100 g of wakame from which excess salt has been removed. Place it in a mesu cylinder and add water so that the total quantity becomes 1000 ml. Leave it for 20 minutes, stirring occasionally. Remove the wakame so that only liquid remains and place the Baume Hydrometer into the cylinder and measure the degree of gravity. After this, the salt quantity may be calculated as shown in diagram p56.</p> <p>3. Calculation of percentage of salt content: Formula: Salt content % $= \frac{100 (S2)}{W \{100 (W-S1) + S1\}}$</p> <p>Remarks:</p> <p>1. 1 kg of wakame is divided into four quarters: W = total amount of wakame in grams that has been removed from the four quarters. S1 = weight of salt in grams sprinkled over the total amount of wakame which has been removed from the four quarters, ie. W. S2 = the salt quantity of the wakame in grams measured by Baume Hydrometer.</p> <p>2. Wakame less than 1 kg: W = total weight of wakame in grams. S1 = salt in grams, sprinkled over the total amount of wakame. S2 = as above (S2)</p>

Diagram showing calculation of salt

Degree of gravity	Salt quantity of wakame (grams)	Degree of gravity	Salt quantity of wakame (grams)	Degree of gravity	Salt quantity of wakame (grams)
1.5	15.4	2.4	24.3	3.3	33.3
1.6	16.4	2.5	25.2	3.4	34.4
1.7	17.3	2.6	26.3	3.5	35.4
1.8	18.3	2.7	27.3	3.6	36.4
1.9	19.3	2.8	28.3	3.7	37.5
2.0	20.3	2.9	29.3	3.8	38.5
2.1	21.3	3.0	30.3	3.9	39.5
2.2	22.3	3.1	31.3	4.0	40.6
2.3	23.3	3.2	32.3	4.1	41.6

This diagram is from the Japanese Agricultural Standard (JAS) for salted wakame.

3. BLANCHED SALTED WAKAME (MANUFACTURING PROCESS AT THE MARKET PLACE)

3.1 Manufacturing Plan: See (1.1.1)

3.2 Receiving and Storage of Raw Wakame and Salt;

Receival of packing materials See 2.2.2

3.2.1 Storage of Blanched-Salted Wakame:

- a) Blanched-salted wakame (salt content 20-25%) should be stored in the fridge at -15°C to -20°C.
- b) Storage will most likely be for a long term period therefore the following points should be observed:
 - i) Temperature differences exist within different areas of the fridge. Try to maintain the wakame at a certain specific temperature.
 - ii) In order to prevent deterioration in the quality of wakame due to over drying or excess humidity, try to prevent a high degree of humidity within the fridge.
 - iii) See 1.8.1.
 - iv) See 1.8.2.

Diagram 14 Receiving standards for blanched-salted wakame:

See page 25? and add to this diagram:

- Moisture content $57 \pm 3\%$
- Salt content % $23 \pm 2\%$

3.2.2 Making up a standard for storage of salt and packing materials:

- a) Storage of salt: See 2.2.6.
- b) Storage of packing materials: See 1.2.6.(e)

3.3 Adding salt and mixing:

3.3.1 Purpose:

By adding salt to the blanched-salted wakame, salt is saturated in the body leaves which makes the wakame's preservatives more effective.

According to test results, salt in the body leaves reaches a saturated state at just over 20% salt, so it is sufficient to add only a small quantity of salt. However, depending upon the condition of the wakame and the environment it was grown in, there are some instances where saturation does not occur instantly. As well as this, due to sales management policy, a substantial quantity of salt must be added to the wakame.

3.3.2 Determining the quantity of salt to be added:

a) Examination at the time of receiving:

First of all, measure the salt content of the leaves of the wakame. This is done in order to meet set standards which state how much salt wakame can contain. Normally, the distribution of salt in wakame is uneven but the moisture content does not vary much. Therefore it is desirable to carry out measurements of these factors in wakame box by box.

Moreover, it may be assumed that the moisture content of wakame varies greatly therefore the measurement of the moisture content is necessary.

A Baume Hydrometer is used to measure the percentage of salt content but this method is complicated and a large amount of testing materials are needed. In cases where the percentage of salt content is below 25%, a simple method employing a salt refractor (measuring device) is used.

b) Calculating Added Salt:

Using the salt content percentage measured in raw wakame and the set standard which states how much salt wakame can contain, a formula is devised which can calculate the amount of salt which should be added.

$$S = \frac{M \times (R-r) + WR}{1-R} \quad \text{Example 1}$$

S: Amount of salt to be added (kg)

M: Weight of raw wakame (kg)

W: Amount of water to be added (kg)

R: Salt content percentage of processed wakame (%x1/100)

r: Salt content percentage of raw wakame (%x1/100)

OR

$$S = \frac{M(R-1)}{1-R} + W\left(\frac{R}{1-R}\right) \quad \text{Example 2}$$

Diagram 16 is a quick reference showing the amount of salt to be added using a case where the raw wakame weighs 15 kg and water has not been added. When water has been added simply add the formula $W(R/1-R)$ to diagram 16, which then becomes the formula for the amount of salt to be added.

Diagram 17 is a "combination" example showing the various cases in which water can be added.

3.3.3 Method of Adding Salt and Mixing:

This method can be done either by hand or by machine.

For the hand method, a stainless steel container is used. For the machine method, either an FRP made mixing machine or a metal machine similar to a concrete mixer is used. (There are called either a salt sprinkler or a wakame mixer.)

DIAGRAM 16: QUICK REFERENCE OF AMOUNT OF SALT TO BE ADDED
(In cases where water is not added and weight of the raw wakame is 15kg)

*B \ *A	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%
20% (3.00 kg)	1.00	2.14	3.46	5.00	6.82	9.00	11.67	15.00	19.29	25.00
21%(3.15kg)	0.8	1.93	3.23	4.75	6.55	8.70	11.33	14.63	18.86	24.50
22%(3.30kg)	0.6	1.71	3.00	4.50	6.27	8.40	11.00	14.25	18.43	24.00
23%(3.45kg)	0.4	1.50	2.77	4.25	6.00	8.10	10.67	13.88	18.00	23.50
24%(3.60kg)	0.2	1.29	2.54	4.00	5.72	7.80	10.33	13.50	17.57	23.00
25%(3.75kg)	0.0	1.07	2.31	3.75	5.45	7.50	10.00	13.13	17.14	22.50
26%(3.90kg)	-	0.86	2.08	3.50	5.18	7.20	9.67	12.75	16.71	22.00
27%(4.05kg)	-	0.64	1.85	3.25	4.90	6.90	9.33	12.38	16.29	21.50
28%(4.20kg)	-	0.43	1.62	3.00	4.64	6.60	9.00	12.00	15.86	21.00
29%(4.35kg)	-	0.21	1.38	2.75	4.36	6.30	8.67	11.63	15.43	20.50

DIAGRAM 17: BLANCHED SALTED WAKAME. "COMBINATION" EXAMPLE⁴⁵ SHOWING THE VARIOUS CASES IN WHICH WATER CAN BE ADDED.

EXAMPLE	No. 1	No. 2	No. 3
Raw Materials (kg)	15	15	15
Table salt content (%)	25	25	25
Moisture content (%)	60	60	60
Amount of salt to be added (kg)	5	10	30
Amount of water to be added (L)	3	4	5
Table salt content (%)	40	50	70
Anticipated table salt content (%)	38.0	47.4	67.5
Anticipated water content (%)	52.2	44.8	28.0

- a) Raw wakame which has been removed from either a wooden box or a vinyl bag should be spread out over either wooden or stainless steel boards. After this, 1/3 of the calculated amount of salt should be added and the wakame should then be thoroughly disentangled by hand before being placed into the mixer. The remaining 2/3 of the salt should be mixed well into the wakame whilst the machine is on. It should take approx, 4-5 minutes for the salt to be completely mixed in. To ensure that the wakame and salt are well combined, there are instances where water or salt saturated water may be added during the process.

Diagram 18 **Examples of Different Kinds of Mixing Machines**

MIXERS - TYPES	A	B	C
Number of Rotations	30	18	22
Time (minutes)	4-5	approx. 5	15-22
Amount mixed (kg's per time)	60	200	60
Specifications - Power			
Kilowatt	0.4	3.7	2.2
Horsepower	0.5	5.0	3.0
Specifications - Drum Diameter (m/m)	830	1250	850
Depth (m/m)	880	1420	820

Machines made by various companies:

- i) Kawashima Konbu (means kelp) Co., Ltd.
Wakame mixer, SHIZUKA
 - ii) Koyo Kikai Sangyo (Machine Industry) Co., Ltd.
Wakame mixer, Type KWM300
 - iii) Koyo Kikai Sangyo (Machine Industry) Co., Ltd.
Wakame mixer, Type KNP6
- b) Special considerations during the main processing of wakame:
- i) Each amount added into the mixer should be appropriate for the mixers size and ability. If an excessive amount is placed into the mixer, mixing will not be even, it will take a longer time and will damage the body leaves of the wakame. Cases where lesser quantities are put into the mixer can also lead to body leaf damage.
 - ii) Some mixers have a tendency for salt to become lodged inside the wall of the machine. It should be removed as soon as possible by a steel or stainless steel spatula but care should be taken not to remove paint from inside the drum mixer.
 - iii) In dry seasons like winter (Japan) the wakame and salt do not thoroughly combine and so a small quantity of water should be

added to assist this. In this case, the water quantity added should be within the set standards (see Diagram 17).

- iv) As a material used for drum mixers, stainless steel is both expensive and heavy so many FRP or iron made drums are used. Stainless steel and FRP made drums do not have problems with rust but the anti-paint used in iron drums has a tendency to come off whilst the drum is in use. If the paint chips off, it mixes in with the wakame along with pieces of rusty iron. It is important to repair and re-paint the drum as soon as possible as well as ensuring that any lodged salt is removed with a spatula.
- v) Because wakame is packed in wooden boxes or polyethylene bags, care must be taken to ensure that no bits of wood, nails or plastic go into the mixer along with the wakame.

3.3.4 Cleaning the mixer:

After using the mixer, thoroughly remove all salt with warm water, making sure that both the inside and outside of the mixer is cleaned. Inadequate cleaning can cause salt induced deterioration of the mixer.

3.4 **Sorting of the Wakame**

3.4.1 Purpose:

Although checking and sorting of the wakame has been done at the place of harvesting, it is necessary to re-check it after the salt treatment to ensure that all the midribs have been removed.

3.4.2. Sorting Method:

- a) Sorting should be done after being treated with salt which is easier than sorting the wakame before treatment. Spread the wakame on a stainless steel or wood en bench making sure that it is still wet and not dirty or contaminated.
- b) After being spread on the bench, the stem, midrib, red and withered leaves and any foreign matter should all be removed.

3.5 **Weighing and Packaging**

3.5.1 Weighing: see 1.6.1

3.5.2 Packaging:

There are two ways of packing blanched, salted wakame:

- a) Simplified packaging - which is where the openings of plastic bags are tied up using rubber bands.

- b) Heat sealing - which is where the openings of the bags are firmly sealed by heat. Simplified packaging is easy to do but has shortcomings in the maintenance of high quality product. There is also a concern that there may be some salt leakage which can damage other products (when it is sold in shops). Therefore this method of packing has found to be unsuitable. Regarding other methods of packing, refer to 1.6.2.

3.6 Inspection of Goods

An example of the goods which contain 40% salt is shown in Diagram 19. The measuring method of the moisture and salt content of wakame has been shown in Diagram 13.

3.7 Storage and Shipment of the Goods

See 1.8.1

DIAGRAM 19: INSPECTION STANDARD OF WAKAME WITH 40% SALT CONTENT. ⁴⁹

ITEM		STANDARD
PACKAGING	Sealing	Bag properly sealed. No wakame caught up in seal.
	Appearance	There should be no pin-holes, dirt or damage to plactis bags.
	Label	Product name, expiry date and whether or not it has passed the Gov. standard should be clear.
WAKAME GOODS	Wakame quality	In good condition and is resilient.
	Lustre	Good, fine lustre; no withered or red leaves present.
	Flavour	Has a good flavour. No other foreign flavours present.
	Appearance	There should be no torn or worm infested leaves.
Mould		none present
Impurities		very little
Foreign Matter		none present
Moisture		50 ± 3%
Salt Content		37 ± 2%

DIAGRAM 20: QUALITY CONTROL OF DRIED WAKAME

	Receiving and storage of raw materials and packaging	Pre-treatment	Drying	Sorting	Weighing and Packaging	Inspection of Goods	Storage and Shipment	
QUALITY CONTROL ITEMS	(1) Inspection at time of receival involves:- . harvester/producer . place & time of harvest . quantity . lustre, appearance, flavour . quality . mould . impurities	(2) Inspection of cleaning:- . water temp . water quality . water quantity . impurities	(4) Inspection of condition of dryness:- . moisture . uneven drying . % of dryness (5) Inspection of stabilized condition:- . degree of moisture	(6) Inspection of leaves:- . appearance . lustre . quality . impurities (6) Disposal of waste products:- . weight . quantity . method	(7) Inspection:- . net weight . sealing condition . correct labelling	(8) i Inspection of Quality . appearance . lustre . body quality . fragrance . mould, impurities . moisture . net weight ii Inspection of Packaging . condition of seals . labelling iii Quality of Product iv Disposal of poor quality boxes & bags v Disposal of poor quality goods	(9) Inspection of Goods . temp & humidity of storage facility . no of days in storage . sorting by brand & grade . degree of damage . quantity of stock (10) Inspection of Shipment . type of goods . weight . appearance . foreign odour . degree of damage . temp & humidity at time of transport	
	(1) Inspection of packaging:- . manufacturer . date of receival . quantity . types . size . labelling (2) Inspection of packaging at time of storage:- . environment . packaging dates . materials remaining (3) Inspection at time of manufacturing:- . quantity & appearance	(3) Inspection of drainage:- . condition . impurities . foreign matter (1) Removal of impurities and foreign matter:- . quantity . method of removal		(6) Removal of impurities:- . weight . quantity . method		(1) Weighing machine - scales:- . adjust for accuracy (2) Packaging machine . adjust for accuracy . adjust for temp. and pressure	(1) Infra-red moisture gauge - check accuracy (2) Pyrostat machine for keeping constant temperature . check temperature	(1) Storage place . adjustment of temp & humidity . suitable place (2) Transport vehicle . temp & humidity of the transport vehicle
	(1) Storage facilities and measures to counteract:- . sunshine . rain . mice . insects		(1) Drying machine:- . setting of temp . degree of humidity (2) Drying place:- . adequate space (3) Stabilizing room . setting of temp . degree of humidity					

* the number of each item refers to the Quality Control Diagram number

DIAGRAM OF THE QUALITY CONTROL PROCESS FOR DRIED WAKAME

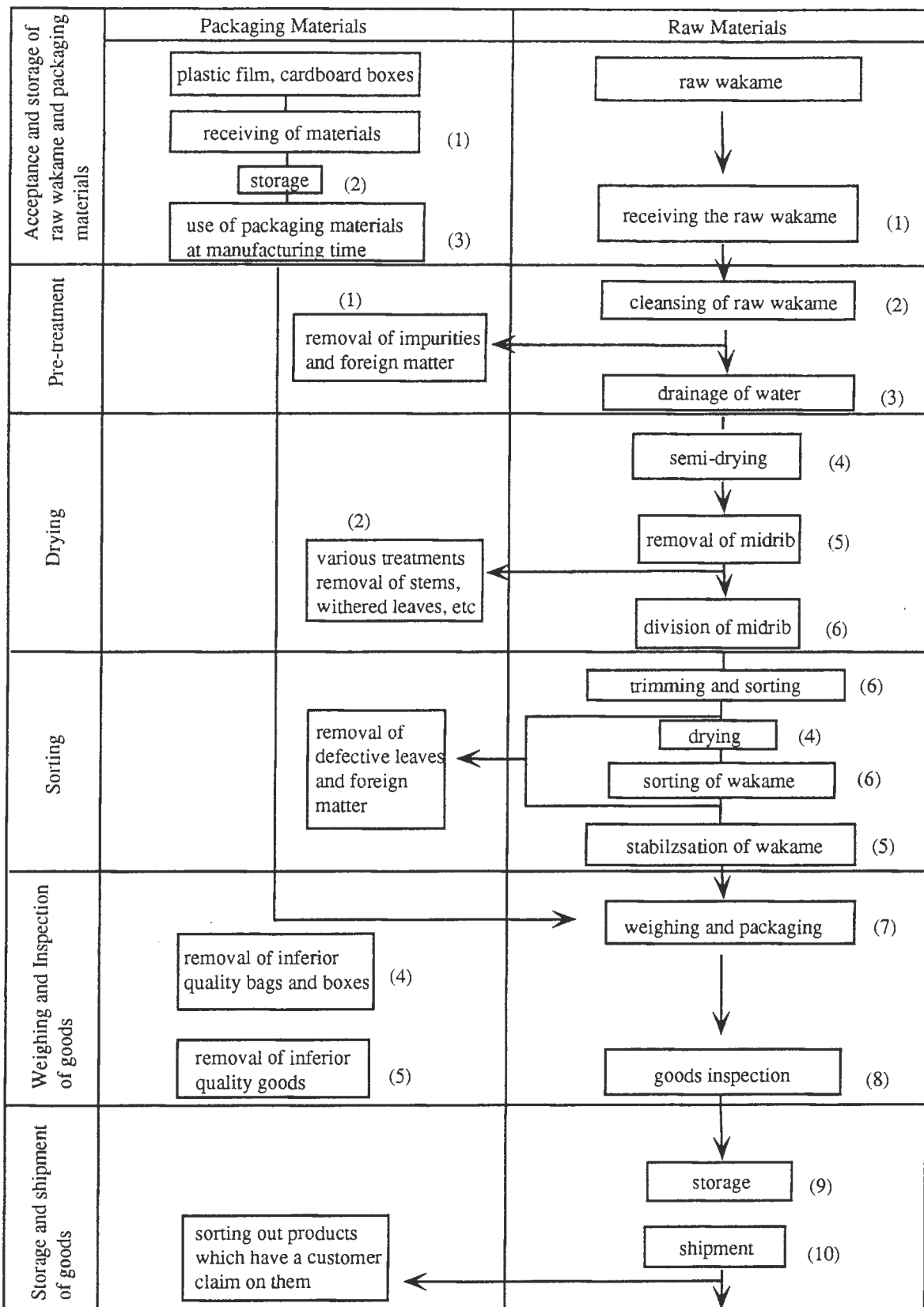


DIAGRAM 21: Processing of blanched salted wakame at the market place: Quality control diagram:

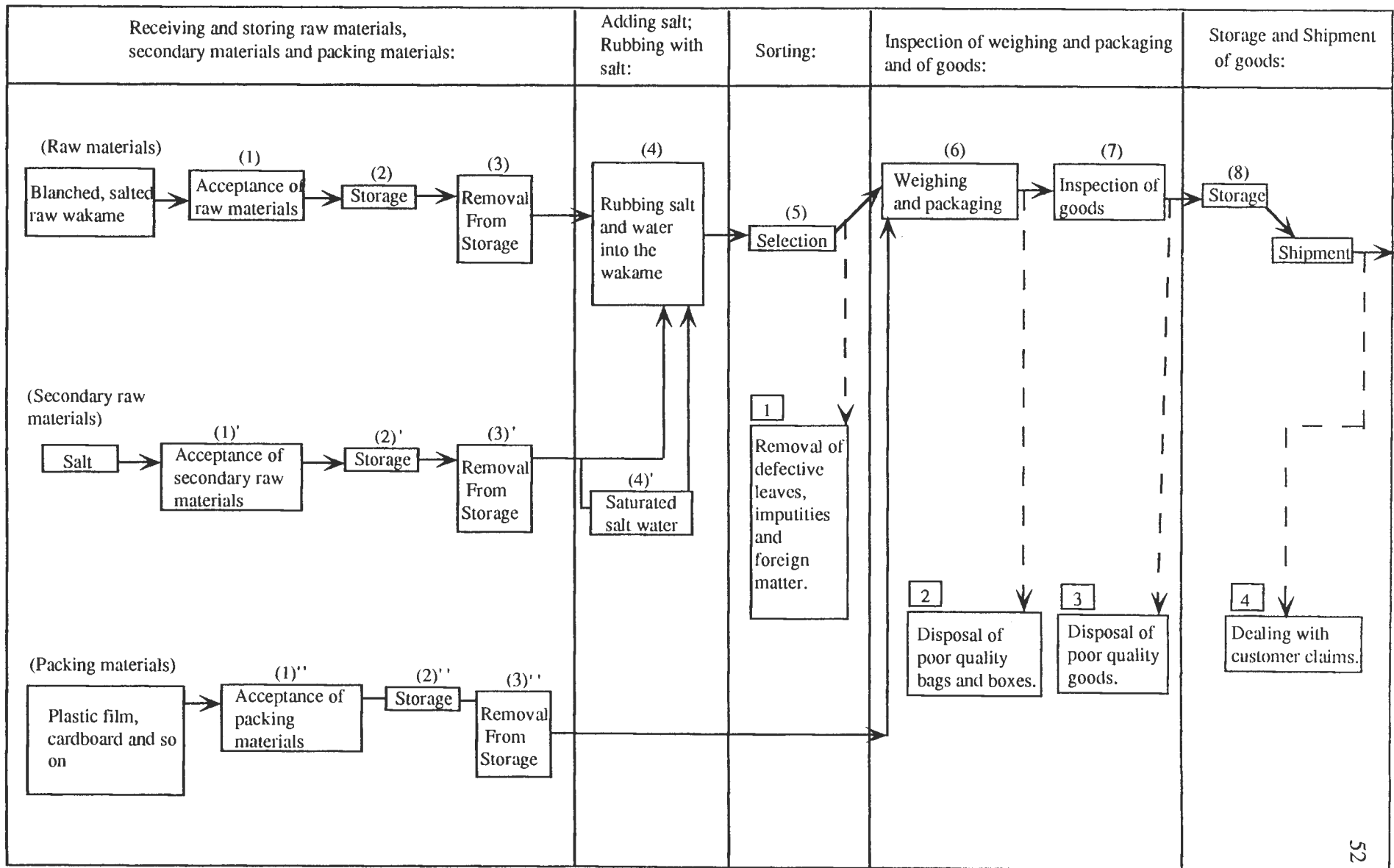


DIAGRAM 22: PROCESSING BLANCHED SALTED WAKAME AT THE HARVEST PLACE (Quality control processing diagram)

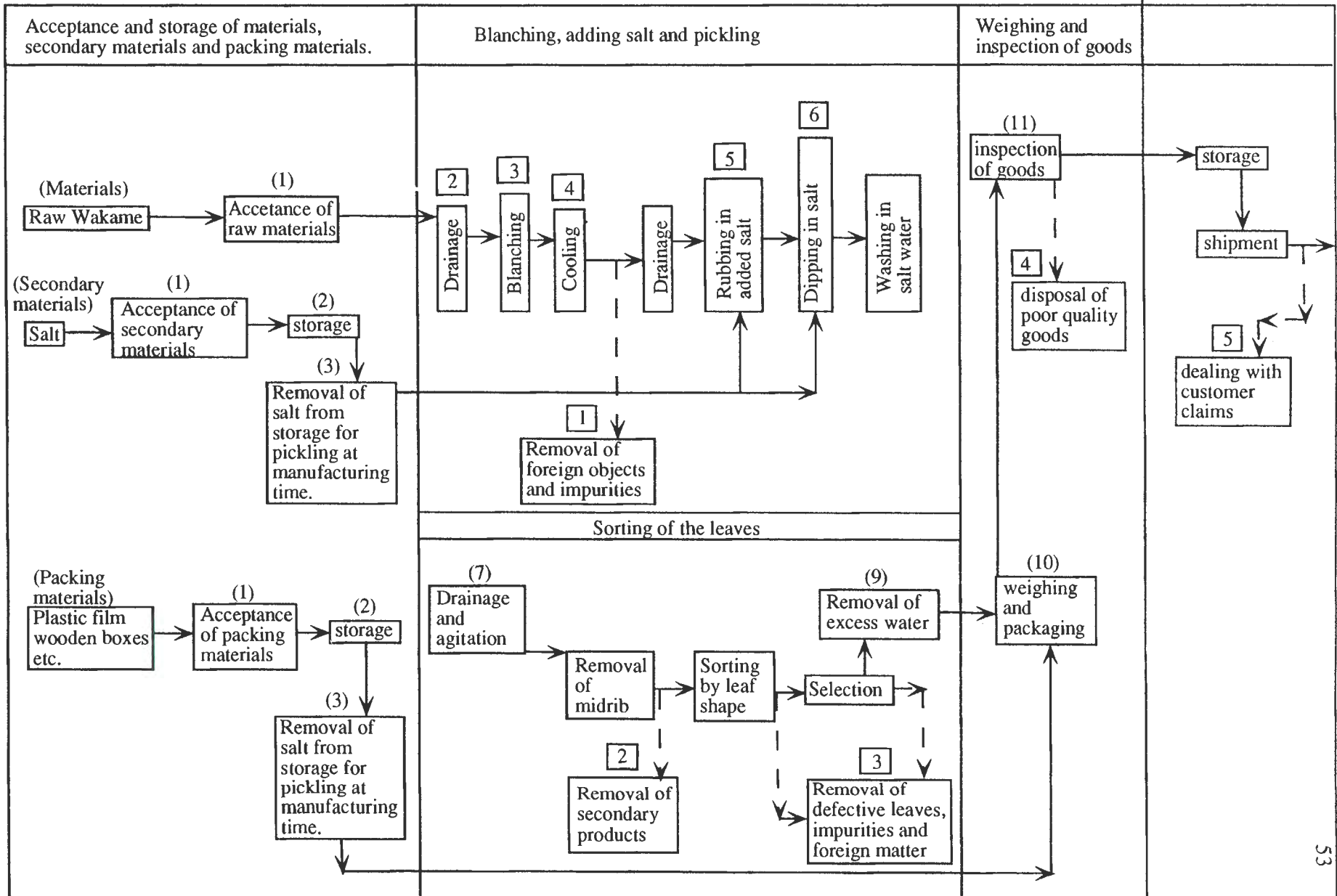


DIAGRAM 23: QUALITY CONTROL OF BLANCHED SALTED WAKAME

Acceptance & storage of raw materials, secondary materials & packaging materials	Blanching	Adding salt & pickling in salt	Sorting	Weighing & Packaging	Inspection of Goods	Storage & Shipment
<p>(1) Inspection of raw materials at time of acceptance</p> <ul style="list-style-type: none"> . wakame producer . place of production . time harvested . types (natural or cultured) . quantity . lustre . appearance . fragrance . body quality . mould . impurities . foreign matter <p>(1) Inspection of secondary materials</p> <ul style="list-style-type: none"> . types . quantity . quality and special characteristics <p>(2) Inspection of storage conditions of secondary materials</p> <ul style="list-style-type: none"> . environment of the storage place . length of storage (time) . total quantity of stock <p>(3) Inspection at time of manufacturing</p> <ul style="list-style-type: none"> . quality . appearance <p>(1) Inspection of packaging materials</p> <ul style="list-style-type: none"> . manufatcurer . date of acceptance of goods . quantity . types of packaging materials . quality of packaging materials . size . appearance 	<p>(2) Inspection of drainage conditions</p> <ul style="list-style-type: none"> . drainage . impurities . foreign matter <p>(3) Inspection of blanching</p> <ul style="list-style-type: none"> . water quality . water quantity . quantity of raw wakame suitable for blanching . temperature . time . ph in hot water . degree of colour change to green <p>(4) Inspection of cooling & drainage</p> <ul style="list-style-type: none"> . water quality . temperature . amount of water . length of time . impurities . drainage <p>(1) Boiling Tub</p> <ul style="list-style-type: none"> . adjustment of temperature <p>(2) ph meter</p> <ul style="list-style-type: none"> . check accuracy 	<p>(5) Inspection of wakame that has been rubbed with salt or has had salt added</p> <p>(6) Inspection of the salt-pickling procedure</p> <ul style="list-style-type: none"> . length of time . conc of salt (baume specific gravity) <p>(7) Inspection of water agitation following agitation</p> <ul style="list-style-type: none"> . condition of the wakame . moisture content . yield rate <p>(1) Pickling tub</p> <ul style="list-style-type: none"> . checking salt concentration <p>(2) Baume hydrometer</p>	<p>(8) Inspection at time of sorting</p> <ul style="list-style-type: none"> . appearance . lustre . body quality . foreign matter <p>(9) Inspection after agitation</p> <ul style="list-style-type: none"> . degree of remaining moisture <p>[1] Removal of defective leaves, impurities & foreign matter</p> <ul style="list-style-type: none"> . quantity . method <p>[2] Disposal of secondary products</p> <ul style="list-style-type: none"> . quantity . method <p>(1) Centrifugal Separator</p> <ul style="list-style-type: none"> . no of rotations . time 	<p>(10) Inspection</p> <ul style="list-style-type: none"> . net weight . seal condition <p>[1] Removal of defective leaves, impurities & foreign matter</p> <ul style="list-style-type: none"> . quantity . method <p>[2] Disposal of secondary products</p> <ul style="list-style-type: none"> . quantity . method <p>(1) Weighing machine (scales)</p> <ul style="list-style-type: none"> . accuracy 	<p>(1) Inspection of Quality</p> <ul style="list-style-type: none"> . appearance . body quality . lustre . fragrance . moisture . salt ccontact <p>(2) Inspection of Packaging</p> <ul style="list-style-type: none"> . seal condition <p>(3) Quantity produced</p> <p>(4) Disposal of poor quality goods</p> <ul style="list-style-type: none"> . quantity . method . prevention of re-occurrence <p>Check function of equipment and machinery</p>	<p>(12) Inspection of storage conditions of the goods</p> <ul style="list-style-type: none"> . temperature & humidity . time of storage . damage to product . quantity of total stock <p>(13) Inspection of goods at time of shipment</p> <ul style="list-style-type: none"> . brand & grade . quantity . appearance . foreign odours . outer damage . temp & humidity at time of transport <p>[5] Dealing with customer claims</p> <p>(1) Storage place</p> <ul style="list-style-type: none"> . adjustment of temp & humidity <p>(2) Transportation</p> <ul style="list-style-type: none"> . adjust temp & humidity

DIAGRAM 24 : QUALITY CONTROL ITEMS

Acceptance and Storage of raw materials, secondary raw materials and packaging materials	Adding Salt	Sorting	Weighing & Packaging	Inspection of Goods	Storage & Shipment of Goods
<p>(1) Inspection of raw materials at time of acceptance . wakame producer . place of production . time harvested . types (natural or cultured) . quality . lustre . appearance . fragrance . body quality . mould . impurities . foreign matter . moisture . salt percentage</p> <p>(2) Inspection of storage conditions of raw material . storage temp & humidity . length of time of storage</p> <p>(3) Inspection of raw materials at time of manufacture . quality . moisture content . appearance . salt percentage</p> <p>(1)' Inspection of secondary raw materials at time of acceptance . types of salt . quality of salt</p> <p>(2)' Inspection of storage conditions of secondary raw materials . environment . length of time of storage . quantity of total stock</p> <p>(3)' Inspection of secondary materials at time of manufacturing . quantity . appearance</p> <p>(1)" Inspection of packaging materials at time of receiving goods . manufacturer . quantity . quality . appearance . types . size . labels . date of acceptance</p> <p>(2)" Inspection of the storage conditions of packaging materials . environment of storage place . length of time of storage . quantity of total stock</p> <p>(3)" Inspection of packaging materials at time of manufacturing . quantity . appearance</p> <p>(1) Storage equipment for raw materials . refrigerator</p> <p>(2) Storage equipment for wrapping materials . preventative measures against . sunshine, rain, odours, mice, insects</p>	<p>(4)" Inspection of saturated salt water . degree of saturation</p> <p>(4) Inspection of quantity of added salt . moisture content . salt percentage . yield rate</p> <p>(1) Mixing machine . no of rotations</p>	<p>(5) Inspection after sorting . appearance . lustre . impurities . body</p> <p>[1] Removal of defective leaves and impurities</p>	<p>(6) Inspection after weighing & packaging . net weight . seal condition</p> <p>[2] Removal of poor quality bags & boxes . quality . method</p> <p>(1) Weighing machine . check accuracy</p> <p>(2) Wrapping machine . check sealing</p>	<p>(7) Inspection {1} Quality . appearance . lustre . body . fragrance . mould . impurities</p> <p>{2} Packaging . seal condition . labels</p> <p>{3} Quality of goods produced</p> <p>(1) Inspection of machinery . check function</p>	<p>(8) Inspection of storage conditions . temp & humidity . length of time . outer condition of packaging . amount of stock</p> <p>(9) Inspection at time of shipment . brand & grade . quantity . appearance . foreign odours . temperature . outer appearance</p> <p>[4] Dealing with customer claims</p> <p>(1) Storage place . adjust temp & humidity . place selection</p> <p>(2) Transportation vehicle . adjust temp & humidity</p>