

*Final Report of Sub-Project*

**A Technology Package of Garlic Processing for Value Addition\***

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By

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## 1. Background and Need

India is one of the leading Garlic (*Allium sativum*) producing countries. The area under cultivation and production of garlic in India (2010-11) is 200.70 thousand ha and 1061.85 thousand tons. Madhya Pradesh, Gujarat, Orissa, Rajasthan, Karnataka, Tamil Nadu, Maharashtra, Bihar and UP are the major Garlic producing states. Study revealed that the area and production of garlic is increasing in most of the states. The prominent Garlic production areas of Rajasthan state are in the districts of Chittoregarh, Jhalawar, Baran and Kota. Rajasthan has a specific Mandi for marketing of Garlic at Chhipabarod in Baran district.

Garlic is the most important foreign exchange earning spicy vegetable crop, commercially grown in India. Indian garlic is now exported even to Pakistan, Thailand, USA, Nepal and Malaysia as well as the traditional market of Bangladesh. About 21,827.16 metric tons of Garlic bulbs amounting to Rs.7,731.52 lakhs were exported during 2010-11(www.nhrdf/database). During the year 2006-07, the export of dehydrated powder and flakes was to the tune of 780 tonnes worth Rs. 437 lakhs and 188 tons worth Rs. 108 lakhs respectively.

Garlic has digestive, carminative and anti-rheumatic properties. It is used in aurvedic formulation since ancient times for curing muscular pain, giddiness, lungs, heating intestinal ulcer, etc. Garlic is consumed as green as well as dried in the spice form and as ingredient to flavour the various vegetarian, non-vegetarian dishes and pickles. Good tasty pickles, chutneys, curry powders are prepared from Garlic cloves. Garlic is also used to disguise the smell and flavour of salted meat and fish. Dehydrated Garlic in powdered or granulated form is being used in place of fresh bulbs in many countries. The main advantages of preparation of value added products from Garlic are to increase the storage life and also to reduce the transportation cost and earn more foreign exchange. Garlic is being exported either in the form of dehydrated flakes or dehydrated powder. Now-a-days the dehydrated Garlic is gaining considerable importance in the world. Also, the dehydrated products are more uniform in flavour than the stored bulbs. From India, large amounts of dehydrated products (flakes, Garlic oil, and dehydrated Garlic powder) are exported to Japan, UK, Italy, Turkey, Germany and France. Other Garlic products are peeled processed Garlic, crushed or chopped Garlic, Garlic granules and fried/roasted Garlic. Fried Garlic granules are also prepared from fresh Garlic bulbs and having good demand in foreign market. Since the cost of fresh Garlic is widely fluctuating (Rs 5 to Rs 100 in a year), simple process technology need to be made available for preparing quality products with long shelf life from Garlic during the season for their use in off-season. Further because lack of available time for kitchen work, the demand for ready to use product is increasing with increase in number working women in urban areas.

As true for any other perishable crop, the Garlic producers and several NGOs of Rajasthan have repeatedly expressed the need for a small scale low cost technology for processing of Garlic for value addition.

Export and value addition in the form of processed products are the important factors for stabilizing prices in internal markets and thereby bringing sustainability in production of certain commodities. To regulate the production and prices it is necessary to develop the dehydration industry in our country. Processing industries in any commodity play an important role in stabilizing prices in domestic markets. Garlic offer very good scope for value addition in the form of dehydrated flakes, powder, granules, paste and Garlic salts. Among all these products, dehydrated flakes and powder of Garlic are important from export point of view.

## **2. Problem**

In a Regional Workshop conducted by RuTAG-IIT Delhi at Lupin Welfare & Research Foundation, on November 25, 2009 at Hotel Kadamb Kunj, Fatehpur-Seekri Road, Bharatpur (Rajasthan), Shri Mohan Bacholia, Secretary, Grameen Vikas Avam Takniki Anusandhan Sansthan, Chipabarod, District- Baran (Rajasthan) had raised the need of small scale low cost technology for processing of Garlic for value addition. He mentioned that in Baran district of Rajasthan, production of Garlic is about 1500-2000 tons per year. The farmers can't store the Garlic for longer period so they sale the Garlic crop on cheaper price just after harvesting since they have no storage facility. Even there was no technology/machine available in the area for processing of Garlic for value addition.

The problem identified by field agencies that had emerged in the workshop at Bharatpur was discussed in the meetings of the Core Group of RuTAG-IITDelhi held on April 15, 2011. It was decided in the meeting that to address the problem, specific detailed information may be collected so that it could be addressed in a scientific way. Therefore, the NGO which had raised the problem, was requested to furnish the detailed information whether the problem of storage and value addition of Garlic still persists, whether any traditional technology or any other method had been tried, scale of production of Garlic in the State, which particular area and what was exactly desired to be done.

The NGO had responded that in Chippabarod Sub-division Garlic is produced in about 10,000 Bighas land and average production is 1500-2000 tones. The farmers store Garlic traditionally in gunny bags for 2 - 3 months after drying by hanging in shady and airy open space. In this method 10 to 20% of Garlic is spoiled. There was no scientific method of storage and processing of Garlic in the area. For want of the technology for Garlic processing for value addition at their disposal, the farmers are forced to go for distress selling their produce at very low prices or face large-scale

spoilage. So the availability of a suitable set of machines to carry out the necessary operations was articulated as a widespread need by the Garlic growers.

### **3. Objectives**

To find out the technology, equipment and machinery for processing of Garlic for value addition for setting up of rural enterprises.

### **4. Action Plan**

- Identification of small scale, low cost Garlic processing machines/technology for setting up of rural enterprises.
- Arrangement of raw material (Garlic)
- Testing of Garlic processing machines available at KVK Anta
- Training of entrepreneurs in Garlic processing for value addition to be deputed by the NGO at KVK Anta,
- Problems observed during the operation of Garlic processing machines, if any.
- Communicating the problem to CTAE, MPUAT, Udaipur for improvement.
- Standardization of the machines for commercial use by the rural entrepreneurs.
- Identification of manufacturer for commercial production of the machine.

### **5. Deliverables**

After identification of small scale, low cost Garlic processing machines, the performance of the machines will be tested for commercial applications. If performance is found satisfactory, the machines would be used for commercial applications. In case some problems are faced during testing of the machine(s), these problems will be communicated to the inventor for conducting further R&D and necessary improvements in the machine(s). The inventor will finally standardize the machine(s) for commercial use. Thus processing of Garlic for value addition would be possible for setting up of rural enterprises in Garlic catchment areas.

### **6. Duration:** Six months.

### **7. Preliminary Investigations**

In response to the above need our surveys revealed that only large scale processing were prevalent. The Private Companies were producing several food products using various forms of Garlic, the equipment and machineries being used by them are of large scale and very expensive which were beyond the purchasing power of rural entrepreneurs. The suitable technology package for small scale operation was not available in the market. Keeping this in view, simple and low cost Garlic processing

machines and technologies for value addition had been developed under All India Coordinated Research Project on Post Harvest Technology by Department of Processing & Food Engineering, College of Technology and Engineering (CTAE), Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur. These were available with them but had not yet been field tested and proven for their viability in context of the actual users. The Department of Processing & Food Engineering, CTAE, MPUAT, Udaipur had showed their willingness to collaborate in the process of field testing and standardization of the machines in this package. These machines were installed at Krishi Vigyan Kendra, Anta, Distt. Baran for demonstration to the farmers. These machines were required to be field-tested with the participation and feedback of prospective users and necessary modifications were to be incorporated to make them user-friendly.

The processing operations with Garlic particularly include Garlic grading, bulb breaking, clove separation, size reduction, peeling, clove flaking, dehydration, blending, packaging, storage, grinding etc. It's processing require special skill and care, because it's essential volatile oil is concentrated in epidermal cell, which is mainly responsible for its characteristic aroma. Following products may be prepared from the processing of the Garlic:

- a) Garlic Flex
- b) Garlic Powder
- c) Garlic Tablet
- d) Garlic Paste
- e) Garlic Pickles
- f) Garlic cloves
- g) Garlic Digestive Churn etc.

Before processing the bulb is broken to separate the cloves. Powder and flex are made after flaking, drying and grinding the cloves. For making paste wet cloves are pilled and grind.

The simple and low cost Garlic processing machines and technologies for processing developed by Department of Processing & Food Engineering, CTAE, MPUAT, Udaipur are:

- a) Garlic Grader
- b) Garlic bulb breaker
- c) Garlic clove flaker
- d) Dry Garlic peel remover (de-skinner)
- e) Fresh Garlic clove peeler

**a) Garlic Grader**

The machine works on the principle of size separation based on rotary screen hole. As the screen with bigger holes of more than 30 mm was not available, it was fabricated

using punch. The MS screen prepared was tested for grading; however skin of about 15 - 20 % bulbs gets scratched/bruised. This was due to inner sharp edges of screen holes. Therefore insulated sheet (used for motor rewinding purpose) was used, as the material has sufficient strength and flexibility to make holes and convert in to cylindrical roller. The desired size holes was cut using SS cutter. The grader was evaluated with the new screens and it was found quite satisfactory with no scratch on bulb surface during grading operation. The material is graded in to three lots i.e. < 30 mm, between 30 - 40 mm (class I & II) and > 45 mm sizes (extra class). Further the samples were drawn from all the discharge outlets it was observed that misclassified material constitutes about 7-8 % on weight basis which is well within acceptable range (size tolerance - not more than 10 % by weight) as per Agmark rule - 2004. Also, Agmark rule - 2004 requires that difference of dia between smallest and largest bulb in a lot should not exceed 15 mm where dia of smallest bulb is less than 40 mm and should not exceed 20 mm where dia of smallest bulb is 40 mm or more. Overall grading efficiency was 82 %, where as separation efficiency for grade I, grade II and grade III was 84, 86 and 89 %, respectively. Approx. 0.2 to 0.8% Cloves gets loosened & separated during operation accumulating to 1.5 % on weight basis. However, damage and peeling of cloves was not observed during operation. The machine was found to have capacity of 100 kg/hr. The cost of machine was estimated as Rs. 35,000/= (inclusive motor) with unit cost of operation as Rs. 30 per/q of Garlic resulting in almost saving of 200% cost over conventional practice.



Fig. 1 Improved Garlic Grader

The cost of Garlic grading unit with bag closer and other accessories such weighing scale, etc was estimated as Rs 50,000. The Garlic grader found economically feasible with 27.18 % return on investment, payback period as 0.36 and 1.78 year for the machine and project cost, respectively and annual net profit of Rs 1.40 lac .Assuming yearly mean wholesale price of Garlic as Rs 20/kg with cost for grade I, II and III as 25, 20 and 15 Rs/kg.

## b) Garlic Bulb Breaker

Bulb breaking i.e. separation of individual cloves from Garlic bulbs is the first and foremost unit operation in processing of Garlic. Garlic bulb breaker has been developed to separation individual cloves from bulbs. The machine consists of a rotating beater with cushioned battens, a concave and an aspirator. The cloves are separated because of the beating action of battens and friction between bulb and concave. The machine has generated lot of interest in Garlic cultivation belt of MP& Rajasthan for separating individual cloves for seed purposes. The machine has been demonstrated & field evaluated at many locations. It is available in two models: (i) hand operated (50 kg/h) (ii) power operated (800 kg/h, 0.5 hp single phase motor). The light stem, root and peels are then winnowed to collected clean cloves. In power-operated model, an aspirator is provided to remove the lighter substance. This machine has an additional utility as the separated individual cloves could also be used as seed material. The cost of bulb breaking through machine comes to Rs 2.50/qtl in comparison to Rs 26.75 through manual bulb breaking.



Fig. 2 Improved Garlic Bulb Breaker

## c) Garlic Clove Flaker

A Garlic clove flaking machine has been developed to press the cloves gently in order to hasten dehydration of Garlic. The machine has 2 rollers fixed in horizontal plane side by side with clearance adjustment (0 to 25 mm) to accommodate the maximum size individual Garlic clove. The roller rotates in opposite direction with the help of 1 hp single-phase motor. Roller clearance of 5 and 10 mm was found optimum for flaking of normal and bold size cloves respectively. The machine has capacity of 420

kg/h with 85% efficiency. It was observed that dehydration time is reduced to just half by this operation.



Fig. 3 Improved Garlic Clove Flaker

#### d) Dry Garlic Peel Remover /De-skinner

The machine works on principal of abrasion and friction during movement of material. The dehydrated flakes (with peel attached) were fed into machine through hopper. The feed control flap was kept full open tom have proper feeding. As the scrubber rotates in the barrel with forward material movement, the peel gets detached from dry material and the mass comes out through discharge spout. The speed of scrubber is kept 160 rpm so as to get de-skinning properly. The aspirator speed is 1440 rpm which helps in sucking out the skinny material. The clearance between the scrubber edge and barrel is 8 mm. The discharge opening can be controlled for changing degree of de-skinning. With the restricted discharge opening the de-skinning is better; however it results into more breakage of flakes and powder making. Therefore, discharge opening was kept full open so that no loss of material occurs, however it was observed that more than one pass is required to get the de-skinning to a satisfactorily level. About 80-85 % de-skinning was observed in two passes. The overall capacity of machine was worked out as 50 kg/hr.

The machine costs Rs. 17,000/= (inclusive motor) with cost of operation as Rs. 53/q dry flakes. The cost of skin removal through conventional manual practice is about Rs. 200/q, hence machine results into about 300% saving in cost of operation. The machine will facilitate entrepreneurs dealing in Garlic dehydration for cost and time saving .



Fig. 4 Improved Dry Garlic Peel Remover/De-skinner

#### e) Fresh Garlic Clove Peeler

The thin papery skin tightly adhered on Garlic clove is to be removed for further processing for pickling, paste formulation, etc. Based on experience various local methods have been used for facilitating peeling of Garlic. In one method, the cloves are dressed with edible oil (2-3%) & salt (1-2%) and then conditioned in open sun (4-5hr) to loosen the skin. In another method, the oil dressed cloves are heat up and stirred in wide pan for a short duration and then peeled manually through rubbing against gunny bag or palm. Though, these local methods alleviate the drudgery of hand peeling, however the hygienic conditions are not maintained, which are must for retaining the quality of products for export as well as for local market. An efficient peeling device is therefore required to gently peel off the skin from Garlic clove without any adverse effect on its shape, structure & aroma. Garlic peeling machine has been developed using the novel concept of gentle impact of compressed air. The developed system consists of a cylindrical peeling chamber with an inlet for feeding cloves and an outlet at the bottom for discharge of peeled clove. The chamber has an opening for entry of compressed air. About 500-750 g conditioned cloves are filled in the batch prototype at a time and compressed air is injected for 45 to 60 seconds. A Garlic bulb breaking machine for separating individual cloves, a dryer for conditioning the cloves and an air compressor for supplying compressed air to the peeler are essential pre-requisites for the peeling system. The study indicated that 96-98% peeling efficiency could be achieved with 18-22 kg/h capacity without any significant damage to cloves.

## 8. Action Taken

The machines developed by CTAE, MPUAT, Udaipur had been installed at Krishi Vigyan Kendra, Anta, Distt. Baran, (Rajasthan) for demonstration to the farmers. But these machines had not been tested in field conditions for adoption by the rural entrepreneurs. We requested Shri Mohan Bacholiya, who had raised this problem, to visit the KVK, Antah and explore the possibilities of demonstrating these machines at Grameen Vikas Avam Takniki Anusandhan Sansthan, Chhipabarod (Baran). Shri Bacholia had visited KVK, Antah, saw the machines and found that these machines would solve the problem of processing and value addition of Garlic in the area. He consulted the local SHGs about installation and demonstration of these machines at their Sansthan at Chhipabarod. Sri Mohan Bacholia again visited the KVK at Antah along with the SHGs Members/farmers and informed that these machines might solve the problem of Garlic storage, processing and value addition and that farmers were very keen and enthusiastic to see the live demonstration of these machines.

Meanwhile, a team comprised of Dr. Jagpal Singh and Shri Ram Gopal Agnihotri from RuTAG–IIT Delhi visited Gramin Vikas Avam Takniki Anusandhan Sansthan, Chhipabarod (Baran) to find out its credentials before finalising it as a field agency for setting up of machines and technology for Garlic processing and value addition.

The observations of the team were as follows:

- The organization was registered in the name of Gramin Vikas Avam Takniki Anusandhan Sansthan. Institute for Rural Development & Technical Research, a translation of it should not be used. It may create legal complication.
- The Sansthan did not have any land and building. The office of the Sansthan was running in rented building of Smt. Kanchan Devi, wife of Shri Mohan Bacholia, Secretary of the Sansthan. For which monthly rent of Rs. 15,000/- was being paid by the Sansthan to Smt. Kanchan Devi. The Rent Document (Agreement) was executed between Mohan Bacholia, Secretary of the Sansthan and his wife Smt. Kanchan Devi, owner of the land and building on 31<sup>st</sup> March, 2009 on the Non-judicial Stamped Paper of Rs.100/- attested by Notary at Chhipabarod.
- A School was also being run by the Sansthan in the rented building of Smt. Smt. Kanchan Devi.
- The staff of the school was being used in various activities of the Sansthan.
- Shri Mohan Bacholia, Secretary of the Sansthan claimed that he had developed rapport with the local people and government officials.
- Shri Mohan Bacholia indicated that the proposed machines for processing and value addition of Garlic will be installed in the rented Land/Building of Smt. Kanchan Devi. It could create legal complication. He indicated that the allotment of land to the Sansthan from the government is under consideration.
- Shri Mohan Bacholia told that the machines were kept just for demonstration at KVK, Anta and those were not in operation.

- The team could not visit KVK Antah. It was closed in the afternoon and concerned officers were not available.

RuTAG-IIT Delhi conducted a Regional Workshop in Rajasthan on December 26 - 27, 2011 at CTAE, MPUAT, Udaipur. The participants of the workshop visited the Garlic processing unit in which live demonstration of Garlic Processing machines such as Garlic Grader, Garlic Bulb Breaker, Garlic Clove Flaker, Dry Garlic De-skinner, Fresh Garlic Clove peeler and other food processing machines was arranged. In the workshop it was decided that Gramin Vikas Avam Takniki Anusandhan Sansthan, Chhipabarod might consider to depute the interested members of SHGs to KVK, Anta along with raw material (Garlic) for training cum processing of Garlic at KVK. The NGO will arrange the marketing of processed products themselves. The CTAE will direct the KVK to allow the deputed SHGs members to use the machines available with KVK for processing their raw material (Garlic) for value addition.

Gramin Vikas Avam Takniki Anusandhan Sansthan, Chhipabarod had agreed to depute SHG's members to KVK, Anta with raw material (Garlic) for training cum processing of Garlic at KVK and arrange the marketing of processed products themselves. After training of the SHGs' members and successful testing of machines for processing of Garlic at KVK, Anta, the Garlic processing machines would be installed in the Garlic catchment areas for training of the rural entrepreneurs. The necessary funding would be arranged by the entrepreneurs for setting up of their rural enterprises for processing of the Garlic for value addition. Later, Shri Mohan Bacholia declined to depute their SHG members for the training. Instead, another Kota based NGO- Paryavaran Parishad, deputed five interested rural entrepreneurs of their area for the training.

The commercial testing cum training programme in Garlic processing was organized by RuTAG-IIT Delhi for entrepreneurs from 28-9-12 to 01-10-12 at KVK Anta for the participants deputed by the NGO – Paryavaran Parishad, Kota. A team from RuTAG-IITD participated in the same. In the course of this project, the performance of the machines developed by CTAE, MPUAT, Udaipur were evaluated for commercial application at KVK Anta with the help of rural entrepreneurs.

Some problems were observed in operation of the machines during commercial testing. These problems were brought to the notice of MPUAT with suggestions for conducting improvements in the machines.

## **1. Garlic Grader**

- a. In the inlet tray Garlic bulbs were falling down due to less height of collar of the tray. So Garlic Inlet Tray collar height needs to be increased.
- b. The ducts of two outlets through which Garlic bulbs come out become block due to being less cross-sectional area of the ducts.
- c. There was rust in the inner side of the Garlic drum casing. Since raw Garlic is processed inside the drum, there were possibilities of contamination of rust with

the Garlic processed material. With a view to prevent the drum from rusting food grade (S.S.304) material should be used.

- d. During operation the machine moves due to vibration since it was not fixed on the platform. Therefore, the machine needs to be properly fixed with grouting nut and bolts.

## **2. Garlic Bulb Breaker**

- a. In the inlet tray Garlic bulbs were falling down due to less height of collar of the tray. So Garlic Inlet Tray collar height needs to be increased.
- b. Outlet duct of the Garlic bulb breaker was jammed after bulb breaking of 30Kg.
- c. There was rust in the inner side structure drum and mild steel jali of the Garlic bulb breaker. Since raw Garlic was processed inside the structure drum, there were possibilities of contamination of rust with the Garlic. With a view to prevent the drum from rusting food grade material should be used.
- d. During operation the machine moves due to vibration since it was not fixed on the platform. Therefore the machine needs to be properly fixed with grouting nut and bolts.
- e. The v-pulley and belt connecting motor and drum was not covered. Proper safety arrangements need to be provided for operators to operate the machine safely.

## **3. Garlic Clove Flaker**

- a. Feeding inlet is being operated manually due to which one additional person was required to operate the opening and closing the feeding inlet. A suitable mechanical device may be designed to operate the feeding inlet.
- b. The processed material fall in outlet tray which throw some of the material away due to not having any cover of the outlet tray. A suitable cover need to be designed/fixed.
- c. There was rust in the outer surface of the roller of clove flaker. Since raw Garlic is processed inside the roller, there are possibilities of contamination of rust with the Garlic. With a view to prevent the roller from rusting food grade material should be used.
- d. During operation the machine moves due to vibration since it was not fixed on the platform. Therefore the machine needs to be properly fixed with grouting nut and bolts.
- e. The v-pulley and belt connecting motor and rollers has not been covered. Proper safety arrangements should be provided for operators to operate the machine safely.

Dr. N.K. Jain, CTAE, MPUAT welcomed the suggestions. He informed that the required major necessary improvements i.e discharge through cross-section, belt-pulley safety cover etc. have been made in the machines. Regarding rusting problem, he mentioned that if machines are in continuous running position, it will not happen

much. However, replacement by SS material is always welcomed at additional cost. As these machines are to be used by small SHGs, societies, hence cost consideration was given due weightage. Foundation/fixing of the machine at one position will certainly help in reducing vibrations/sound.

Thus improvisation (as needed) and standardization of the complete technology package had been carried out in the next generation of machines available at MPUAT. The commercial feasibility of using these for required processing had also been established. Also the Govt. of Rajasthan had declared 75% subsidy on these machines. This will enable the small farmers of the region to adopt this technology. The manufacturer of these machines had been identified at Udaipur through CTAE, MPUAT. The farmers/entrepreneurs may place orders for purchase of machines from the identified manufacturer.

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