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STUDIES ON PERFORMANCE OF RECENT TECHNIQUES ADOPTED IN VARIOUS STARCH AND SAGO INDUSTRIES

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ABSTRACT

The Sago industries are traditional agro-based processing industry with huge employment potential in India. Tapioca roots are one of the richest sources of starch and it contains 30% of starch. The sago industries are extracted the starch from tapioca roots using conventional method and mechanical method. The recovery of starch from tapioca root is 16-18% by conventional method and 22-25% by mechanical method. The average loss of starch is only 5% while peeling the roots using mechanical peeler where as the starch loss is 10-15% in manual peeling. In mechanical process, the time required for extraction of starch from starch milk is 60 min where as the conventional method required the time for separation of starch from starch milk is 15 to 20 hours. From the analysis of drying system, it was found that the moisture is removed from 40 to 10% about 90-120 min at 50-60ºC using hot air dryer in drying of starch. Also found that the moisture is removed from 30 to 10% about 60 min at 30-35ºC using hot air dryer and about 90 min at 30-35ºC using poly sheet dryer in drying of sago.

KEYWORDS: Starch and sago, mechanical Peeler, centrifugal fiber extractor, hot air dryer, moisture removal, drying time

INTRODUCTION

The sago industries are agro based seasonal food industries with huge employment potential in India. Tapioca Sago is generally known as sago (Sabudana in Hindi or Javvarishi in Tamil) in India and its botanical name is "Manihot Esculenta Crantz Syn.Utilissima". Tapioca roots have high resistance to plant disease and high tolerance to extreme stress conditions such as periods of drought and poor soils [1]. Sago industries are using tapioca roots as the basic raw material for production of starch and sago. Tapioca roots are one of the richest sources of starch and it consists of 25-30% starch (total carbohydrates), 7-12% proteins, trace amount of fats and moisture. It is an important staple food cum industrial crop of the tropics. More than two third of the total production of tapioca in the world is used as staple food, 5-7% as industrial raw material and the rest as animal feed. There are more than 1000 tapioca processing units in India producing starch and sago in cottage and small scale sectors [2]. Currently, Tamilnadu stands first in respect of processing of tapioca into starch & sago and sago was produced first in Salem District.

Initially, a traditional method was used for production of starch and sago in India. It is well known that traditional method of starch and sago production was a time and labor intensive process and consequently, the production is very low both in quantity and quality. Then the sago industries are introduced the mechanical equipments in the production of starch and sago due to continuous development of industrial technology. The principles and methods of starch and sago production is almost the same for both traditional and mechanical method, but differ only in the equipment which is used and the scale of operation [3]. The traditional method of starch extraction from roots not only ineffective and inefficient but also the starch quality produced is low. In

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contrast, mechanical processing of sago palm, beside much more effective and efficient, the starch produced has higher quality and is more hygienic.

Almost all tapioca processing industries in India have two major problems. The first problem is the huge requirement of water for better extraction of starch from tubers and the second is generation of large volume of effluent. Many factories are being closed due to the unavailability of water. Hence there is a need for suitable methods or equipment and technology to reduce the water consumption in tapioca starch production without sacrificing the starch extraction efficiency [4]. Currently, few industries are adopted the modified unit operations in the processing of tapioca to reduce water consumption and to increase the efficiency of starch extraction. From the literature it was found that none of the authors have been studied the performance of recent techniques adopted in sago industries in India. The objective of this paper is to study the development of techniques in processing of tapioca roots for production of starch and sago and to analyze the performance of different drying methods adopted in various sago industries located in Salem District.

MATERIALS AND METHODS

The study was conducted in the tapioca processing units at Salem District, Tamilnadu, India. Twenty factories of different production capacities were selected. The water requirement, effluent generation, product output and efficiency of each unit operations were measured in each factory for five days continuously and the average value recorded for analysis. The Moisture content (weight basis) of tapioca starch or sago is measured by Bureau of Indian standards method.

RESULTS AND DISCUSSION

1. Development of technology for processing of tapioca roots in sago industries

The major unit operations involved in starch and sago production are peeling and washing, rasping and pulping, screening, settling and purification of starch, pulverization, globulation, sizing, Roasting, drying, polishing and packing [5]. The figure 1 and 2 shows the manufacturing process flow sheet for production of starch and sago by conventional and mechanical methods.

(i) Peeling and washing

In traditional method, tapioca roots are washed manually to remove adhering dirt. The tubers are then cut longitudinally and transversely to a depth corresponding to the thickness of the peel, which can be easily removed. Any dirt remaining on the smooth surface of the core of the tuber is then washed off and the peeled tubers are put in a concrete tank, where they remain immersed in water until taken out for rasping.

There is a loss of value product and starch in manual peeling, the mechanical dirt remover and peeler machine are adopted in the process. The mechanical peeler machine consist of a cylindrical rotor fitted with a number of cutting blades and found that the peeling efficiency is 90-95% and the starch loss is about 5%. The outer skins are separated from tapioca roots before enter into peeler for peel. This is the value added product and converted into briquettes which can be used as fuel. The white skin obtained from peeler is dried and used as cattle feed. In order to accomplish a more effective and fast method of washing, mechanical washers are employed in the process to reduce man power and the washed peeled tubers are immersed in water until taken out for rasping.

(ii) Rasping and pulping

The peeled roots are subjected to high pressure water jets during conveying for rasping. It is necessary to rupture cell walls in order to release the starch granules. Rasping facilitates rupture of cell walls and release of starch granules. This is carried out by pressing the roots against a swiftly moving surface provided with sharp protrusions. A large quantity of water is added to the roots during this process. The cell walls get ruptured during rasping and the whole root is turned into a mass in which substantial portions of the starch granules are released [6]. It is difficult to remove all the starch in a single operation even with efficient rasping devices. Therefore, the pulp is subjected to a second rasping process after straining. Rasping is usually done in machines using a wooden roller over which the sheet metal rasping surfaces are nailed with the burrs facing outward.

Later the sago industries are adopted the cutter and crushing machine to recovery more starch in single operation. The water addition during rasping is reduced and found that final slurry having more of starch and less of water. Starch recovery from tubers depends on the efficient crushing operation. It is reported that in order

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to have the kinetic energy necessary to obtain the rasping effect, the rasping motor would have a linear velocity of about 25 m/s.

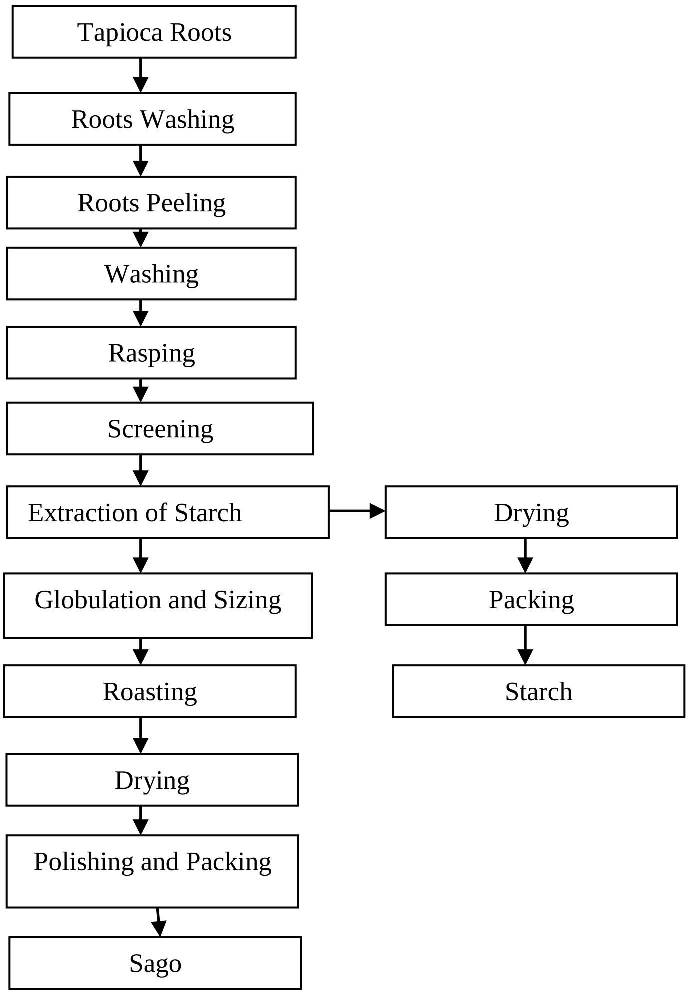

Fig.1: Manufacturing process flow sheet for production of starch and sago by conventional method

(iii) Screening and Settling & purification of starch

After rasping, the pulp is screened in the shaking screens. In separating the pulp from the free starch, a liberal amount of water is added to the pulp as it is delivered by the rasper and the resulting dispersion is stirred vigorously before screening. The fresh pulp after mixing with water in distribution tanks is transferred by pipes to the higher end of the screen. During screening, the dispersion passes through a set of screens with increasing fineness, the first one retains the coarse pulp, the others the fine particles. The 'overs' from the first screen are returned to the fine rasp and then returned for re-screening.

After the separation of starch by screening, the starch milk is subjected to a settling process. The starch milk is pumped to a tank fitted with effluent outlets at varying heights. Settling takes about 6 to 20 hours depending on the quantity as well as the size of the settling tank. Settling is an important unit operation in cassava processing where the extracted starch is separated from its aqueous dispersion under gravity [7]. The upper layer of sediment flour, which has a yellowish green tint, contains many impurities and is generally scraped off and discarded. The remaining moist flour is then stirred up with water and transferred to another tank where starch is settled. The final settled moist floor is removed by using a crowbar. Sreenarayana *et at.* (1990) reported that a rapid separation of starch from the milk and the removal of impurities from the colloidal material could be achieved by centrifugation.

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Recently few sago industries are adopted the decanter, centrifugal fiber extractor, hydro cyclones and dewatering centrifuge instead of screening and settling tanks to maximize the separation of starch. The slurry pulp from rasping section is passed through decanter to remove waters completely from pulp. After that the pulp is again mixed with fresh water and passed though fiber extractor and fibers are separated from fine starch. The separated fibers are dried and used as cattle feed. In this process, it was found that the recovery of starch is more and addition of fresh water is less than screening method. After separation of fibers, the starch milk obtained from fiber extractor is subjected to hydro cyclone process. In this process, the fresh water is mixed with starch milk and starch is separated from its aqueous dispersion which contains many impurities under centrifugal action. Then the fine starch slurry is subjected to dewatering centrifuge process where the water is completely removed under centrifugal action. From this process it was found that the separation of fine starch takes place in one hour than conventional settling process.

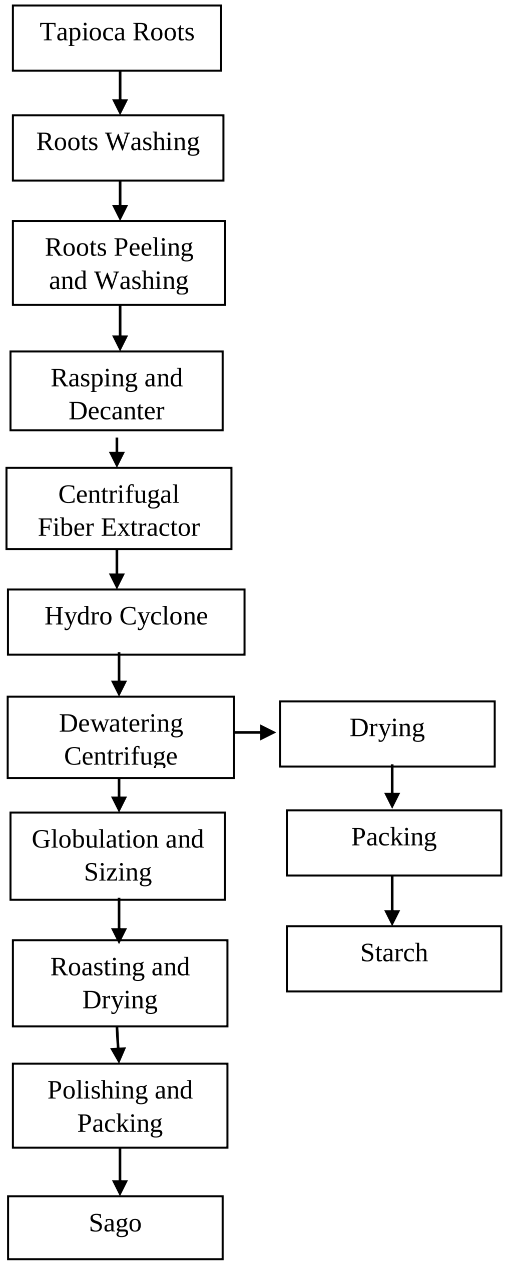

Fig.2: Manufacturing process flow sheet for production of starch and sago by conventional method

(iv) Drying of starch

Drying of starch is generally done by sun drying in the drying yards and then sent for further processing for packing of starch [8]. The wet starch contains 35-40% moisture and found that this moisture is reduced up to 10-11% in sun drying about 10 to 12 hours depending on the intensity of sun shine. Later the starch industries are adopted the hot air dryer for drying of starch due to less intensity of sun shine during winter season and requirement of huge area of cement floor. From this process it was found that the moisture is reduced up to 10-11% about 90-120 min at 50-60ºC. The biogas from anaerobic digester is utilized as fuel for generating hot air which saves energy and man power. The dried starch is subject to a packing process where it is packed in different weights.

(v) Pulverization, globulation and sizing

For production of sago, the wet starch contains 35-40% moisture is subjected to pulverization, globulation and sizing process. The Pulverization is done in spike mill and the wet starch is subjected to globulation in vibratory unit provided with gunny cloth surfaces forming two pouches. Each pouch or sack can hold 10 to 12 kg of wet starch powder for globulation. The globulated starch powder is then graded in oscillating screens and the granule of sago consist of 6mm is formed. The other size granules are returned to spike mill to crush again for formulation of granules.

(vi) Roasting

The granules of sago from sizing section is given a mild roasting on hot plates at about 60-70°C for about 20-25 minutes and found that the moisture content is reduced up to 30-35%. Initially the sago industries are utilized the manual roasting pan to roast the sago and also they utilized the fire woods as heating medium for roasting pan. But this manual operation consumes lot of time, man power and fire woods. Later on most of the sago industries are developed the auto roasting system to roast the sago. From this process it was found that the moisture content is reduced up to 30-35% about 15-20 minutes at 60-70ºC. The biogas from anaerobic digester is directly utilized as the heating medium in auto roasting pan instead of fire wood which saves energy and man powers. Some of the sago industries are installed the thermic fluid heater for auto roaster and biogas is utilized as fuel in thermic fluid heater.

(vii) Drying

The roasted sago contains 30-35% moisture is dried in the sun on cemented floor for about 8 to 10 hours depending on the intensity of sun shine. Later on the sago industries are introduced the hot air dryer and carbonated poly sheets dryer due to less intensity of sun shine during winter season and requirement of huge area of cement floor for drying. The biogas from anaerobic digester is utilized as fuel for generating hot air which saves energy and man power.

(viii) Polishing and packing

The sago from drying section is passed through the polishing machine and the sago lumps are breaks down and get uniform polish. The polished sago is passed through the vibrating screen to get different uniform sizes. Then the sago is finally packed in jute bags.

2. Performance analysis of drying system adopted in sago industries for drying of starch and sago

The performance of drying system adopted in various starch and sago industries located in Salem District were studied. The effect of drying time on percentage moisture removal in starch by sun drying is shown in Fig.3. From the figure, it was observed that the percentage moisture removal increases with increase in drying time up to 11 hours beyond that no significant effect. The average moisture content in wet starch is 40% and it is removed from 40 to 10% in sun drying about 10 to 12 hours depending on the intensity of sun shine. The Fig.4 shows the effect of drying time on percentage moisture removal in starch by hot air dryer. From the figure, it was found that the percentage moisture removal increases with increase in drying time up to 90 min beyond that no significant effect [9]. Also found that the moisture is reduced from 40 to 10% about 90-120 min at 50-60ºC in hot air dryer and the hot air dryer is more efficient than sun drying.

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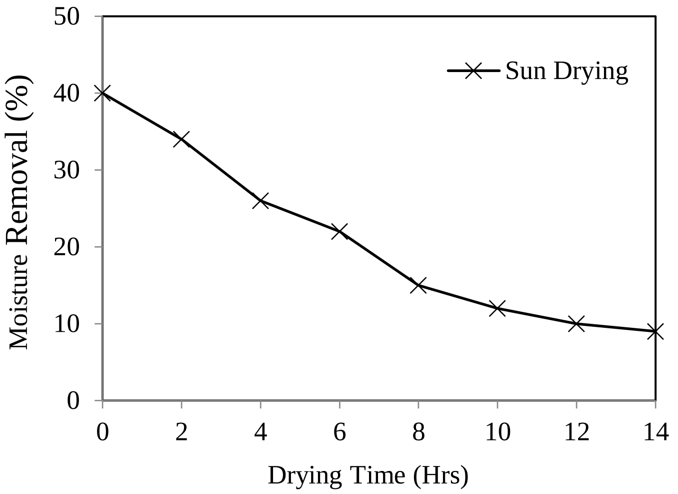

Fig.3: Effect of drying time on moisture removal in starch by sun drying

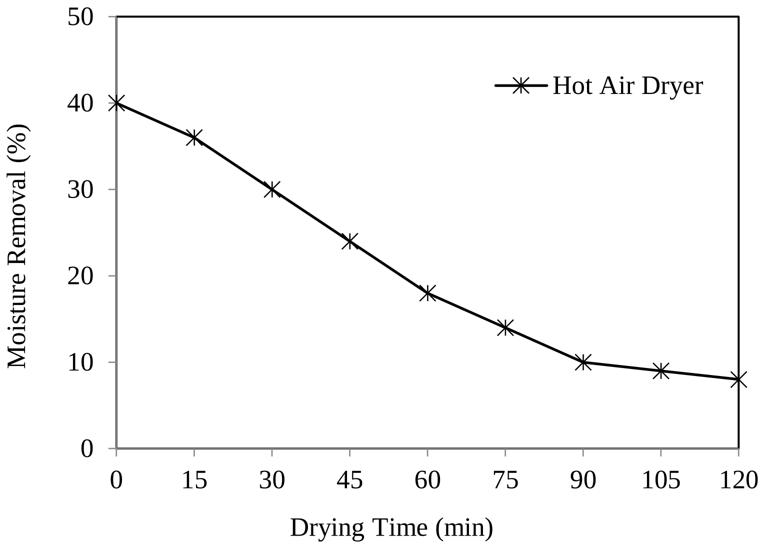

Fig.4: Effect of drying time on moisture removal in starch by hot air dryer

The formulated sago from wet starch in globulation and sizing section is having 40% moisture. The moisture content is reduced from 40 to 30% in roaster at 50-60ºC about 15-20 min during roasting of sago. The effect of drying time on percentage moisture removal in sago by sun drying is shown in Fig.5. From the figure, it was observed that the percentage moisture removal increases with increase in drying time up to 10 hours beyond that no significant effect. From the results it was found that the moisture is reduced from 30 to 10% in sun drying about 8 to 10 hours depending on the intensity of sun shine. The Fig.6 shows the effect of drying time on percentage moisture removal in sago by hot air dryer and carbonated poly sheet dryer. From the figure, it was found that the percentage moisture removal increases with increase in drying time up to 60 min in hot air dryer and up to 90 min in poly sheet dryer at 30-35ºC, beyond that no significant effect. From the results, it was observed that the moisture is removed from 30 to 10% about 60 min at 30-35ºC in hot air dryer. Similarly the moisture is reduced from 30 to 10% about 90 min at 30-35ºC in poly sheet dryer. The hot air dryer is more efficient than poly sheet dryer and sun dryer.

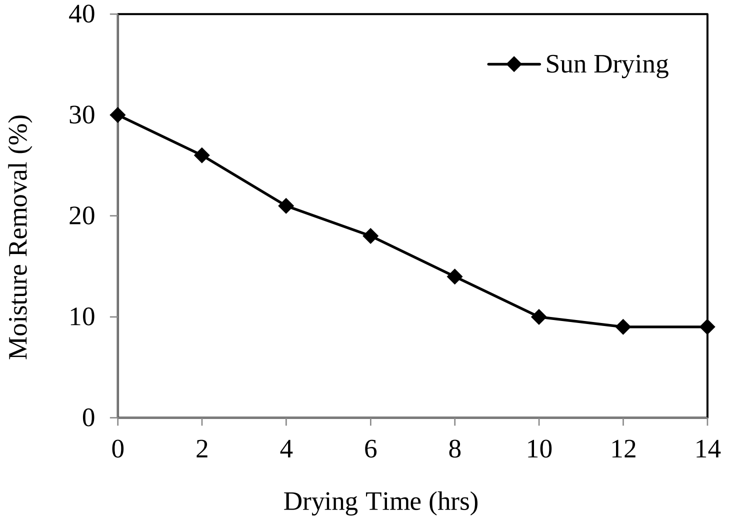

Fig.5: Effect of drying time on moisture removal in sago by sun drying

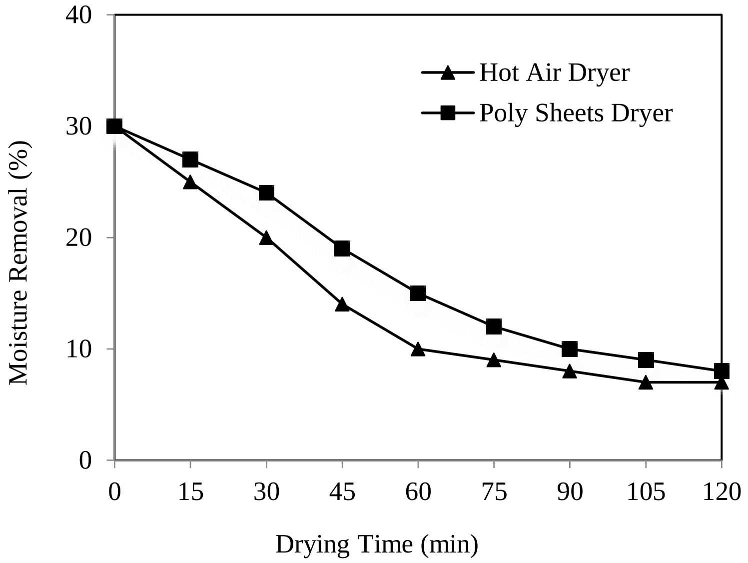

Fig.6: Effect of drying time on moisture removal in sago by hot air and carbonated poly sheet dryer

CONCLUSION

Most of the tapioca processing industries in India adopted the mechanical method than conventional method for better extraction of starch and production of sago. The mechanical peeler, crushing machine, decanter and fiber separator, auto roaster and hot air dryer are the important unit operations involved in the tapioca processing. In peeling section, it was found that the efficiency of peeling machine is 95-98% and the starch loss is about 5% where in conventional methods the starch loss is more than 10%. In starch separation section, the starch is separated from starch milk in one hour using decanter and fiber separator where in settling tank process the time required for separation of starch is 15 to 20 hours. The hot air dryer study clearly showed that the percentage moisture removal increases with increase in drying time up to 90 min for drying of starch and 60 min for drying of sago, beyond that no significant effect. From the analysis of tapioca processing techniques, it is observed that the recovery of starch from tapioca root is 15-18% in conventional method and 22-25% in mechanical method. Also found that the mechanical method saves energy and man power than conventional method.

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