International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 18, 2018, pp.-7192-7195.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

STUDIES ON EXTRACTION OF STARCH FROM DRIED AND FRESH MANGO SEED KERNEL

PARV NAYAK* AND KALPANA RAYAGURU
Department of Agricultural Processing and Food Engineering, College of Agricultural Engineering & Technology (CAET), Orissa University of Agriculture and Technology, Bhubaneswar, Orissa, 751003, India
*Corresponding Author: Email - parvnyk2112@gmail.com

Received: September 14, 2018; Revised: September 25, 2018; Accepted: September 26, 2018; Published: September 30, 2018

Abstract: The aim of this research was to explore the production of starch from mango (*Mangifera indica*) seed kernel (dried and fresh) that can be used mainly in the industrial field economically. Mango fruits of Totapuri variety were subjected to a pulper in order to obtain the pulp, peel and seeds separately. The component analysis indicated that the pulp and peel recovery, seed kernel, stony endocarp, were 62.6%, 15.5%, 9.5%, 5.3%, respectively with 7.1% loss of pulp. Mango seeds were dried in a hot-air cabinet dryer at 600C for 4 hours and the separated kernels were subjected to extraction of starch through wet grinding method. The starch yield, starch purity, residual fat and ash content of starch were calculated and compared with that prepared from fresh seed kernels. The results showed that starch was extracted from mango seed kernels, both dried and fresh, with yield of 64.41±5.51 and 47.37±2.56% of starch, respectively. The residual mango kernel powder obtained was 25.47±2.12 and 50.88±2.21%, respectively. Further, the results indicated that the starch extracted from dried and fresh kernels had purity of 66.44±2.54 and 69.19±1.44%, residual fat content of 1.09±0.08 and 0.199±0.03% and residual ash content of 0.28±0.04 and 0.22±0.03% respectively.

Keywords: Mango Seed kernel, Starch yield and purity, Ash and Residual content

Citation: Parv Nayak and Kalpana Rayaguru (2018) Studies on Extraction of Starch from Dried and Fresh Mango Seed Kernel. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 18, pp.- 7192-7195.

Introduction

Utilisation of food waste materials is a driver for reducing environmental impacts along with obtaining economic benefits through food processing industries. The food, pharmaceutical and textile industries use starch widely for different applications. Mango belongs to the genus Mangifera of the family Anacardiaceae, one of the most favoured and commercially valuable fruit growing throughout the tropics and is used in a variety of food products. Approximately, 40% waste is generated during processing of mangoes, 12–15% and 15–20% of which consists peels and kernels, respectively [1]. Development of different value added functional foods and nutraceuticals are possible due to the presence of substantial amount of phytochemical in these mango wastes. The kernel obtained after decortication of mango seed can be utilized as a supplement to wheat flour or for extraction of edible oils [2]. Mango kernels were found to contain 6.0% protein, 11% fat, 77% carbohydrate, 2.0% crude fiber and 2.0% ash, based on the dry weight average [3]. As inferred by [4] mango seed kernel has potent antioxidant activity with relatively high phenolic contents. It is a food reserve substance in plant and is widely used in pharmaceutical industry. The use of starch as food additives in form of thickeners is a well-known facts. It can also be used to produce a number of value added food products. Starch has been extracted from mango seed kernel by previous research worker using either chemical or fermentation method [1,5,6]. The mango seeds contain approximately 58% starch on dry basis [6]. The characteristics of mango kernel starch are as good as the other commercial starches obtained from wheat, corn, rice and potato and could be effectively used as starch source. Thus, mango seed kernel flour can also be used for edible purpose, especially a substitute for wheat flour. Considering the above benefits, the present investigation focuses on the component analysis of one of the ruling variety of the state as explore the possibility of extraction of starch from the fresh and dried mango seed kernel using mechanical method.

Materials and Methods

Component Analysis of raw material

Ripe mangoes of Totapuri variety were procured from the local supermarket, Bhubaneswar, India. Mango fruits were cleaned manually and foreign material were removed. These were then subjected to pulper (B. Sen Barry and company) to separate the different component. The motor operated pulper having a roller fitted with brushes inside the outer casing, through which all these components were separated and recovered through different outlets.

Experimental Procedure of Starch Extraction

Mango seeds were obtained from the mangoes, which were then used for extracting starch from the kernels as described by [1] with some modification. Starch was to be isolated from the ripe mango seed kernel both from fresh as well as dried. The seeds were dried in a hot-air cabinet dryer at 60^{o}C for 4 h. Mango seeds were decorticated to separate the kernel from the stony endocarp. Seeds kernel were cut into crosswise small pieces of 5-10 mm and washed in water. The kernel was subjected to wet-grinding method by adding distilled water at a proportion of 1:2. Slurry was filtered with muslin cloth and the filter cake obtained there of washed with distilled water, then filtrate slurry was allowed to stand for 2 h. The filter cake was separately dried to be used as residue for flour making. The filtrate was further washed. The upper non-white layer was decanted and white layer was re-suspended in distilled water and the process was repeated twice. The starch collected was dried in hot air cabinet dryer for 6 h at 50^{o}C. Starch was sieved with strainer 100 mesh/inch for better homogeneity in size. The procedure of extraction of starch from fresh kernel was exactly the same as above, by passing the drying operation as shown in [Fig-1].

Analysis of Extracted Starch

Moisture content

The moisture content was measured according to [7] on dry basis using hot air digital oven (UNI-Tech, model UTS1.01C having an accuracy of ±1^{0}C.

Carbohydrate content

The carbohydrate content was determined according to [7]. A 0.1 g of sample was weighed accurately in electronic weighing balance (Wenser AN ISO 9001:2008 Company, having accuracy 0.01g) and 5 ml of 0.25 N HCl was added to it. The mixture was placed in boiling water bath (keeping closed with cotton plug and aluminum foil) for 3 hours. After cooling, sodium carbonate was added pinch by pinch until the effervescence stops. The solution was then filtered and made up to 50 ml in a standard flask. A 0.1 ml of this with 0.9 ml distilled water, added with 1 ml phenol and 5 ml sulphuric acid formed the extract. The standard solutions were made with 0.01% glucose solution in 0, 0.2, 0.4, 0.8 and 1 ml proportions with corresponding proportions of distilled water that makes 1 ml, added with phenol and sulphuric acid as done for the sample extract. The carbohydrate percent of the starch samples were calculated using the following formula

$$C.H\ (\text{in }\%) = [(c\times7)/\ (20\times W)]\times100$$

Fat content

The fat content was evaluated according to [7]. The bottle and the lid in the incubator were placed at 105^{0}C overnight to ensure that weight of the bottle is stable. About 3-5 g of sample was weighed to paper filter and wrap. The sample was taken into extraction thimble and transferred into soxhlet apparatus. About 250 ml petroleum ether was filled into the bottle and it was placed on the heating mantle. The soxhlet apparatus was connected to the water flow to cool them and then the heating mantle was switched on. The sample was heated for about 14 h. The solvent was evaporated by using the vacuum chamber. The bottle was incubated at 80-90^{0}C until solvent was completely evaporated and bottle was completely dried. After drying, the bottle with partially covered lid was transferred to the desiccator to be cooled. The bottle was reweighed with its dried content.

$$Fat\ \% = \frac{Weight\ of\ \ Fat}{Weight\ of\ \ Sample} \times 100$$

Total Ash Determination

Ash content was estimated by the measurement of the residue left after combustion of 2g of starch in a silica dish at 450^{0}C and the percentage of ash was calculated relative to the amount of sample combusted [7].

Yield and Purity

The yield of starch was determined as the quantity of starch isolated from the fresh seed kernel as well as dried seed kernel, expressed in percentage. The purity of starch was determined based on the moisture content and carbohydrate content. The purity of starch was calculated according to [8] as follows

$$Starch\ Purity\ \% = \frac{C.H.\%}{(100 - M.C.\%)} \times 100$$

Where, C.H is the carbohydrate content (%) and M.C is the moisture content(% w.b.)

Statistical analysis

The data reported in all the figures are averages of triplicate observations. The data were subjected to statistical analysis for measures of central tendency and analysis of variance for dependent parameters using MS Excel 10. α = 0.05 was used to compare the methods for any significance difference.

Results and discussions

Proportion of components of mango fruit

Material balance and proportion distribution of ripe mango fruits was studied and depicted in [Fig-2] and [Fig-3]. [Fig-2] shows the mass of mango fruit parts viz. pulp, peel, seed endocarp and kernel per 10 kg of fruits in form of a flow chart. The same has been expressed in percentage through a pie chart [Fig-3]. It was observed that the fruits had about 62.6 and 15.5% as pulp and peel respectively. The stony endocarp of the seed and the seed kernel together constituted 14.8 per cent of the whole mango fruit, out of which mango kernel alone represented 9.5% of whole fruit. The stony endocarp which is usually discarded was about 5.3%. It was estimated that during processing of mango fruits, about 7.1% of fruit pulp was lost. This was the total pulp loss partly due to adherence of pulp on the outer surface of the roller, within the brush and partly due to residual pulp sticked to the seed surface. Results obtained were in agreement with the findings of [9] who reported that seed and kernel comprised 18 and 10% respectively of total fruit. [10] They founded that kernel constituted 10% of the fruit weight. Varietal differences in mango fruits causes variation in the proportion of kernel and peel present in fruits. The seed content varied from 9 to 23 % of fruit weight which largely depended on the variety of mangoes [11]. The present study was undertaken for the Totapuri variety of mango fruits and the proportion percentage for different components are well within the range reported by previous workers.

Table-1 ANOVA for extraction method on starch recovery and residual fat and ash content

ANOVA for Starch Yield						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	435.542	1	435.542	23.597	0.008	7.708
Within Groups	73.827	4	18.456			
Total	509.369	5				
ANOVA for Starch Purity						
Between Groups	11.343	1	11.343	2.661	0.178	7.708
Within Groups	17.05	4	4.262			
Total	28.394	5				
ANOVA for Residual Fat content						
Between Groups	1.306	1	1.306	12.241	0.008	5.317
Within Groups	0.853	8	0.106			
Total	2.159	9				
ANOVA for Ash content						
Between Groups	0.005	1	0.005	4.32	0.106	7.708
Within Groups	0.005	4	0.001			
Total	0.01	5				

Extraction of Starch

The result of starch extraction process is presented in [Fig-4]. The effect of extraction methods on starch recovery and starch purity along with their standard deviation values are depicted in the figure. The result showed that starch yield extracted from dried mango seeds kernel and fresh mango seed kernel were 64.41± 5.51 and 47.37± 2.56% respectively. Similar results were reported in literature by [12] (52.8 to 65.37%); (47 to 59%) [5]. [Fig-4] also indicated that the starch extracted from dried and fresh kernels had purity of about 66.44± 2.5 and 69.19± 1.44% respectively.

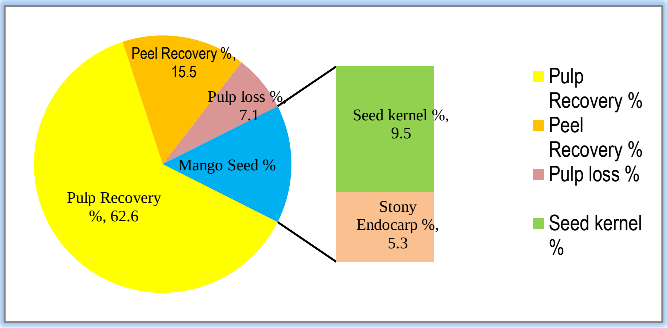

Fig-3 Proportion of different component of mango fruit

[Table-1] reveals the analysis of variance of starch yield and starch purity among the samples extracted from dried seed kernel and fresh seed kernel. The starch yield obtained from dried seed kernel was significantly (p=0.008) higher than that obtained from fresh kernel whereas no significant (p=0.178) difference could be observed in starch purity at 5% level of significance. The starch content extracted from fresh kernel was less which could be due to rapid enzymatic action in the sample. Because in this sample, after sedimentation the non-white layer observed was thicker than the other sample and had to be discarded. This could be the possible reason for low starch recovery. Since the unit operation followed for the samples were same, no significant difference in starch purity was observed.

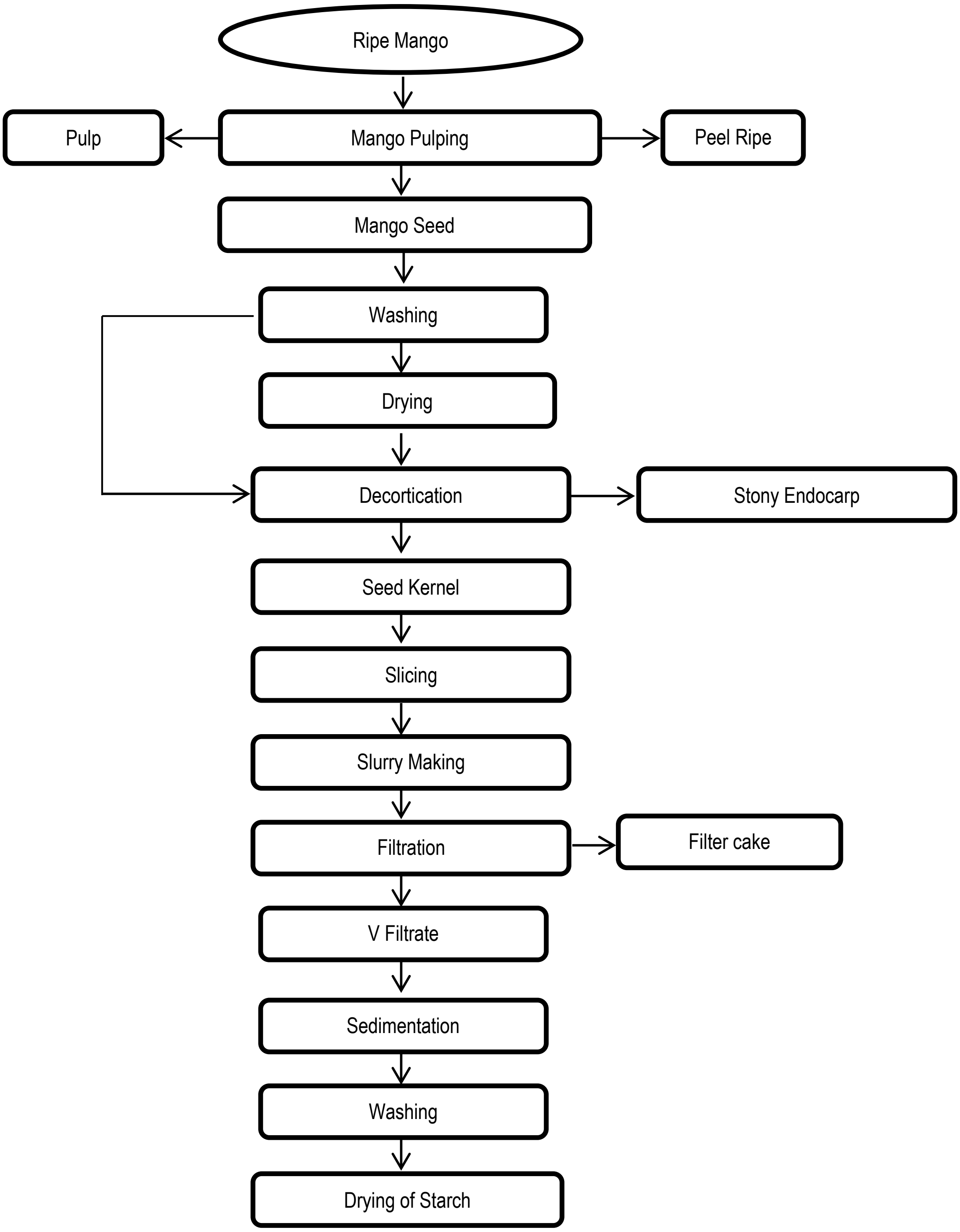

Fig-1 Flow chart for extraction of starch from mango kernel

However, the starch purity in both the cases is low as compared to the market starch having 92.59% purity. Therefore, it is necessary to improve upon the starch extraction process. Effect of drying of kernels prior to starch extraction on residual fat and ash content of starch has been presented in [Fig-5]. Presence of both fat and ash in starch is vital from quality of starch point view as the use of starch for further value addition is dependent on presence of these components. From [Fig-5], it is seen that the residual fat content in starch obtained from dried kernel is higher (1.091±0.081%) than that obtained from fresh kernel (0.199±0.031%). This could be due to removal of fat along with the residue during filtration where as it got stabilized in dried kernel leading to higher residual fat content in starch obtained from dried sample [Table-1]. On the contrary, the residual ash content of starch extracted from dried kernel (0.28±0.04%) was not significantly (p= 0.106) different than that (0.22 ±0.03%) from fresh kernel [Table-1] and [Fig-4]. The ash content of the starch is an indication of the total mineral content. In both the cases the values are higher than that obtained (0.07 to 0.29%) as reported by [12].

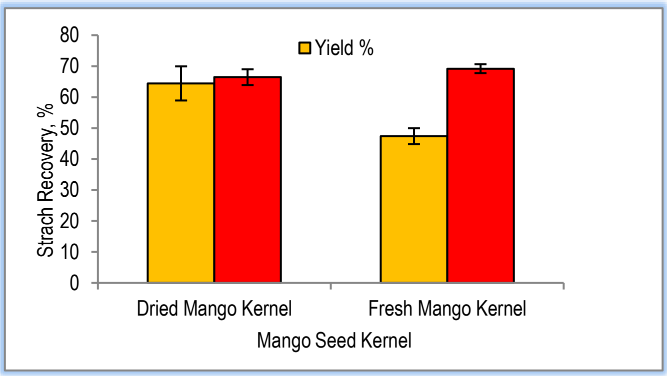

Fig-4 Effect of extraction method on starch recovery

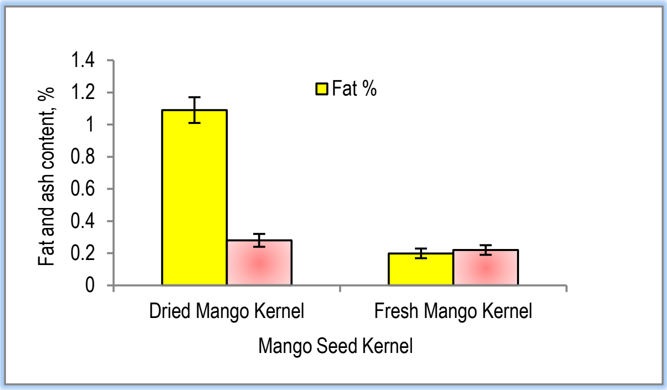

Fig-5 Effect of extraction method on residual fat content and ash content

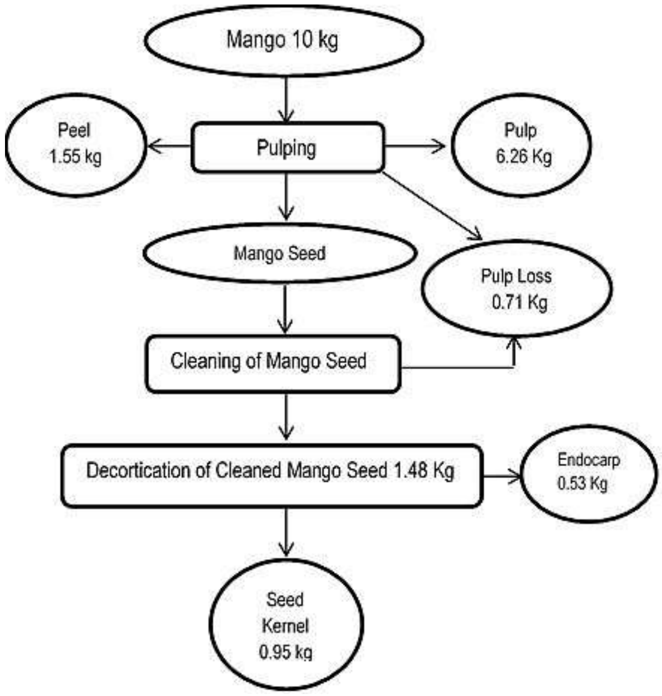

Fig-2 Material balance of Mango Processing

Conclusion

The dried mango seed kernel resulted in significantly higher starch yield (64.41± 5.51%) than the fresh kernels (47.37± 2.56%). However, starch purity in dried kernel was less than 70% and residual fat content was greater than 1% for which it is suggested to improve the starch extraction method by increasing the frequency of washing and another unit operation. The residual ash content however, is higher in starch extracted from dried sample. Considering all the above results it is suggested to dry the mango kernels prior to extraction of starch in order to obtain higher yield and better starch quality.

Application of research: Mango seeds, a waste material that is disposed of after consumption of mangos can be used as a potential alternative resource for starch production. It has wide applications in the food, pharmaceutical, textile, paper, cosmetic and construction industries.

Research Category: Agricultural Process and Food Engineering

Abbreviations:

°C - Degree Celsius
Kg - Kilogram
h – Hours
d.f – Degree of freedom
SS - Sum of Square
MS- Mean Square

Acknowledgement / Funding: Author thankful to College of Agricultural Engineering, Orissa University of Agriculture and Technology, Bhubaneswar, 751003, Orissa, India

***Research Guide or Chairperson of research: Dr Kalpana Rayaguru**
University: Orissa University of Agriculture and Technology, Bhubaneswar, 751003, Orissa, India
Research project name or number: Nil

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References:

[1] Kaur M., Singh N., Sandhu K.S. & Guraya H.S. (2004) *Food Chemistry*, 85, 131–140.
[2] Tandon D. K. & Kalra S. K. (1989) *Beverage and Food World*, 16(1), 21-22.
[3] Zein R.E., El-Bagoury A.A. & Kassab H.E. (2005) *Journal of Agricultural Science, Mansoura University*, 30, 3285–3299.
[4] Soong Y.Y., Barlow P.J. and Perera C.O. (2004) *In IFT annual meeting, July* 12-16, Las Vegas.
[5] Sonthalia M. and Sikdar D.C. (2015) *International Journal of Technical Research and Applications*, (3), 346-349.
[6] Nawab A., Alam F., Haq M.A., Hasnain A. (2016) *Int. J. Biol. Macromol.*, 68 (2016), 919–928.
[7] AOAC (2000) *Official Methods of Analysis. 17th Edition, The Association of Official Analytical Chemist, Gaistherburg, MD, USA*.
[8] Tuffour E. (2013) *Kwame Nkrumah university of Science and Technology, Kumasi, Ghana*.
[9] Dhingra S. and Kapoor A.C. (2007) *J. Sci. Food Agric*., 36, 752-756.
[10] Elegbede J.A., Achoba I.I. and Richard H. (1995) *Journal of Food Biochemistry,* 19, 391-398.
[11] Kittiphoom S. and Sutasinee S. (2013) *International Food Research Journal* 20 (3), 1145-1149.
[12] Hassam L.G., Muhammad A.B., Muhamma A.B., Aliyu R.U., Idris Z.M., Izuagie T., Umar K.J. and Sani N.A., (2013) *IOSR Journal of Applied Chemistry,* 3(6), 16-23.