International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 10 | Oct -2016 www.irjet.net p-ISSN: 2395-0072

A NOVEL APPROACH OF CASSAVA BAGASSE IN DIFFERENT FROM TWO STARCH AND EFFECT OF HYDROCHLORIC ACID

Dr.A.Jaganathan[1], S.Muguntha Kumar[2]

[1]*Principal / Secretary, Food Craft Institute, Hoshiarpur, Punjab, India*

[2]*Assistant professor, Department of Hotel Management & Catering Science*
Muthayammal College of Arts & Science, Namakkal, Tamilnadu, India.

Abstract - *The main objective of the present work was to study the thermal properties and rheological behavior of natural and modified organic cassava starch with standard solutions of hydrochloric acid in concentrations 0.1 and 0.2 mol L-1 and in temperatures 25 and 45ºC, respectively, as well as verify the structural changes up to the surface of granules. Cassava is an agricultural crop that occupies an important place in the diet of people of many countries in tropical and sub-tropical regions. Cassava bagasse is a by-product from industrial processing that is generated in great quantities and it can exhibit about 40-50 % of starch in its composition, in dry basis. Two samples, one moist (sample A) and another dry (sample B), were supplied by two cassava starch industries. The samples were analyzed by physicochemical, thermo analytical (TG, DTA, DSC), rheological (RVA) and micro-structural methods (NC-AFM) that demonstrated that the temperature of the industrial drying (around 150 ºC) was not very well controlled, reaching higher temperatures, reaching decomposition of organic matter condition causing changes.*

Key Words: Modified starch, Thermal Analysis, Cassava, thermal analysis, atomic force microscopy, RVA

1. INTRODUCTION

Starch is a natural polymer, which has many and unique properties. It is a non-toxic, biocompatible, biodegradable and abundant polysaccharide; regenerated form carbon dioxide and water by photosynthesis in plants Cassava (*Manihoc esculenta*, Crantz) is a species of the *Euphorbiaceae* family and one of the most important root crops in tropical regions in terms of food energy production. Tropical root and tuber are rich sources of starches, and vitamins and minerals (traces), and they serve as either subsidiary or subsistence food in parts of the tropical belt. Cassava (*Manihot esculenta,* Crantz) is an important vegetable crop in tropical regions, where on a food energy production basis; it ranks fourth after rice, wheat and corn as a source of complex carbohydrates These root and tubers crops contain 70-80 % water, 16-24 % starch and small quantities (<4 %) of proteins and lipids and other substances.

Organic foods are produced using methods that do not involve modern synthetic inputs such as synthetic pesticides and chemical fertilizers: they do not contain genetic modifications and are not processed using irradiation, industrial solvents, or chemical food additives. Several countries require producers to obtain a special certification in order to market food as "organic". Organic starch is extracted following the same rules, and for this study. Starches are of great value for the food industry because they contribute greatly to the textural properties of many foods and are used in food and industrial applications as a thickener, colloidal stabilizer, gelling agent, bulking agent and water retention agent.

Starch, in its native form, does not always have the physical or chemical properties appropriate for certain types of processing. Some of these constraints include, insolubility in cold water, low stability to freeze-thawing and syneresis, which in some cases makes them difficult to use. Starch modifications can be made by chemical, enzymatic and physical methods that promote specific functional properties for industrial purposes.

Cassava (*Manihot esculenta* Crantz) is considered to be an important source of food and dietary calories for a large part of the population in tropical and sub-tropical countries in Latin America, Africa and Asia. It is a rich source of starch and also contains fibres, proteins, lipids, sugars and other substances (Cereda, 2001). Cassava bagasse is a fibrous material resulting as a by-product of the cassava starch processing industry. It is an agro-industrial residue that can offer economic opportunities as an alternative substrate for the fermentation industry. This residue contains starch, about 50 % on a dry weight basis, a considerable quantity of natural fibre and low contents of ash, protein and lipids (Carta, 1999; Matsui *et al*., 2003; Pandey *et al*., 2000a; Texeira *et al*., 2005).

Starch and cellulose are natural polysaccharides and they are the most abundant renewable resources available to mankind. They are both glucose polymers that are photosynthesized by solar energy. Plants have starch as a reserve and cellulose as the structural basis of the plant cell wall. These polymers also constitute a major energy source

in human and animal diets. They are widely used as raw material in numerous industrial applications such as textiles, food, paper, paint, petroleum, pharmaceutical, bioprocess, and others (Matsui *et al*., 2003; Pandey *et al*., 2000a; Pandey *et al*., 2000b; Richardson *et al.,* 2003; Sivaramakrishnan*, et al.,* 2007; Sun *et al*., 2013).

The main objective of the present work was to study the thermal, rheological and structural behaviour of natural and modified organic cassava starch with standard solutions of hydrochloric acid (0.1 and 0.2 mol L-1) with controlled temperature (20 and 45 ºC). The raw and the hydrolyzed organic cassava starches were submitted to thermal analysis, using the thermo analytical techniques: simultaneous thermo gravimetric and differential thermal analysis (TG–DTA); differential scanning calorimetric (DSC); the structural changes of granules by the non-contact atomic force microscopy (NC-AFM) and pasting properties by the rapid viscoamylographic analysis (RVA).

Starch is the main source of carbohydrates in the human diet due to its abundance in nature. Starch granules are made up of glucose polymers, named amylose and amylopectin, and they are found inside vegetable cells, from where they are extracted for industrial applications by the food, textile, pulp and paper industries among many. Amylose is a mostly linear chain and typically consists up to 3000 anhydroglucose units (AGU) primarily interconnected by α-(1→4) glycosidic linkages; it is also reported that it contains a few branched chains (Vilaplana *et al.,* 2012). Amylopectin is a highly branched polysaccharide consisting of -(1→4) linked glucose with -(1→6) linkages at the branch points (Beninca, *et al.,* 2012; Costa *et al.,* 2011; Leivas *et al.,* 2012; Matsuguma *et al.,* 2009; Vilaplana *et al.,* 2012).

Cellulose is a uniform, linear, glucose polymer and is the most abundant of all naturally occurring substances. Polymers constitute approximately one third of all vegetable matter as they are the principal structural cell wall component of all major plants, such as trees, annual plants, mosses, seaweeds and cotton, in which cellulose occurs in varying amounts (Richardson *et al.,* 2003; Abdul-Khalil *et al.,* 2012). According to the literature (Pandey *et al.,* 2000), the industrial processing of cassava is carried out mainly to isolate starch, which generates a great quantity of solid residue that contains 30-50 % of starch in dry.

Whenever a material undergoes a change in physical state, is transformed from one crystalline form to another, or it reacts chemically, heat is either absorbed or liberated as energy (endothermic or exothermic processes, respectively) (Cereda, 2001; Lacerda *et al.,* 2008a). Many of such processes can be initiated simply by raising the temperature of the material. Differential thermal analysis (DTA) and differential scanning calorimetric (DSC) techniques have proven most useful in providing basic information on starch gelatinization and retro gradation (Lacerda *et al.,* 2008b). Thermogravimetry (TG) is a technique in which the change in sample mass (m, mass-loss or gain) is determined as a function of temperature and/or time. DTA is a technique that measures the difference in temperature between the sample and the reference. DSC is a technique whereby the difference in energy input into a substance and a reference material (sample and reference) is measured as a function of temperature, while both materials are subjected to programmed heating or cooling (Wendlandt, 1986). In this present study, cassava bagasse samples were obtained from two starch processing plants with different moisture contents; one industrially dried and another moist. Selected physicochemical, thermo analytical, rheological and microscopic methods were employed for their characterization.

2. MATERIAL AND METHODS

Differential scanning calorimetry (DSC): The DSC curves were obtained using thermal analysis system model DSC-Q200 (TA-Instruments, USA) and were recorded under an air flow of 50 mL min-1, heating rate of 5.0 ºC min-1 and samples weighing about 2.0 mg dispersed in 10 µL of distilled water. The instrument was calibrated using Indium 99.99% purity, m.p. = 156.6 ºC, H = 28.56 J g-1. A 4:1 (water:starch, w/w) mixture was prepared and maintained for 60 minutes in order to equilibrate the moisture content. The aluminium crucibles were sealed in order to study the gelatinization process.

Samples of cassava bagasse were obtained directly as a by-product from two starch industries (A) and (B) located in the northwest region of Paraná State and the south of São Paulo State, Brazil. The first sample (A) was obtained with high moisture content (80.5 %) and the sample (B) was obtained with low moisture content (8.2 %); this last sample had brownish coloration due to the industrial drying process that exceeded 150 ºC. The samples were milled and sieved at 20, 150 and 270 mesh (840, 105 and 53 µm, respectively). Physicochemical analysis: The moisture, protein, reducing sugars, ash and pH contents were determined according to protocols of the Association of Official Analytical Chemists (AOAC, 2010) and of Adolfo Lutz Institute, (IAL, 2008).

Simultaneous thermo gravimetric and differential thermal analysis (TG-DTA): The samples were heated from 30 ºC to 600 ºC using open alumina crucibles with approximately 6.0 mg of sample under a synthetic air flow of 100 mL min−1 at a heating rate of 10 ºC min−1. The samples were analyzed in a SDT-2960 thermo balance (TA-Instruments, USA). The instrument was preliminarily calibrated with two weight standard references and with standard calcium oxalate monohydrate. All mass loss percentages were determined using Universal Analysis-2000 data analysis software.

Rapid Viscoamylographic Analysis (RVA): The pasting properties of the samples were determined using RVA-4

(Newport Scientific, Australia). A suspension of 3 g (6 % moisture) cassava bagasse and starch in 25 g of distilled water underwent a controlled heating and cooling cycle under constant shear (160 rpm), where it was held at 50 ºC for two min, heated from 50 to 95 ºC at 6 ºC min-1, and held at 95 ºC for 5 min, cooled to 50 °C at 6 ºC min-1 and held at 50 ºC for 2 min **(**Sun *et al.,* 2013; Beninca *et al.,* 2012). Non-contact Atomic Force Microscopy (NC-AFM): The micro-images of each sample were observed with high resolution by an Atomic Force Microscope model SPM-9600 (Shimadzu, Japan), using the non-contact method (Beninca *et al.,* 2012; Juszczak *et al.,* 2008). The technique allowed us to observe the surface of the studied cassava bagasse, and it was possible to identify starch granules and natural fibres.

Five portions, each with twenty five grams of cassava starch were separated and identified as (a), (b), (c), (d) and (e). The untreated sample (a) was kept in a desiccators over anhydrous calcium chloride until constant mass. The samples (b) and (d) were treated by one hour with 100 mL of standard HCl solutions 0.1 and 0.2 mol L-1, respectively, with continuous stirring and controlled temperature (45 ºC). The samples (c) and (e) were treated by one hour with 100 mL of standard HCl solutions 0.1 and 0.2 mol L-1, respectively, with continuous stirring and controlled temperature (25 ºC). After this time, each suspension was filtered, washed with distilled water until complete elimination of chloride ions (test with H+/AgNO3 solution), dried at room temperature and kept in a desiccator over anhydrous calcium chloride until constant mass.

TG and DTA curves were recorded using a simultaneous SDT 2960 System (TA Instruments) under a 100 mL min-1 air flow purge gas, and a heating rate of 10 ºC min-1. The initial mass sample was about 7 mg. Alumina crucibles (sample and reference) were used for the TG and DTA experiments [11-13]. DSC curves were recorded using a DSC Q 200 System (TA Instruments) under an air flow of 50 mL min-1, heating rate of 10 ºC min-1. A 4:1 (water: starch, w/w) slurry was prepared and maintained for one hour in order to equilibrate the moisture content. The aluminum crucibles were sealed with hermetic lid in order to study the gelatinization process.

The pasting properties were performed in an Rapid Viscoanalyzer RVA-4, (Newport Scientific) was used for studying the starch samples apparent viscosity profile during cooking in the presence of excess water (dispersions of starch at 10 % w/w, dry basis). The Standard analysis profile of the Thermo cline for Windows® software was employed for the analyses and the conditions involved increasing starch dispersion temperature from 50 to 95 °C in a 6 °C min-1 rate, keeping at 95 °C for five minutes and then cooling until 50 °C at the same temperature rate. The apparent viscosity was expressed in centipoises (cP).

3. RESULTS AND DISCUSSION

The non-contact atomic force microscopy technique (NC-AFM) was used to observe the surface of the untreated (Figure 5) and treated organic cassava starch granules, and allowed us to obtain micro-images with high resolution of each sample. The measurements were performed at ambient conditions and a pellet of each sample was fixed directly on an AFM sample holder, which was enough to immobilize the granules and prevent contamination of the starch surface.

In the laboratory, sample A was dried carefully in an oven with forced air circulation at 45 ºC for 24 hours, ground and sieved at 20, 150 and 270 mesh, and kept in a desiccators over anhydrous calcium chloride until constant mass. The cassava bagasse is hygroscopic: even in a desiccators it retains moisture content, and the values can be observed from the physicochemical and thermo gravimetric determinations (IAL, 2008; Wendlandt, 1986). All the TG-DTA curves of the untreated and treated samples have shown similarity with mass loss (TG) in three main steps corresponding to endo or exothermic events (DTA).

TG-DTA curves show the first mass loss attributed to dehydration, with corresponding endothermic, followed of stability. The second and third mass losses are due to decomposition of organic matter which begins with a little endothermic samples (a) and (c) attributed to depolymerization of the chains which occurs in an oxidizing atmosphere where are the formation of pyrodextrins [15-16], followed by two exothermic peaks, in an oxidizing atmosphere with ash formation. The little endothermic peaks after stability, not occurs in the thermal decomposition of the samples (b), (d) and (e). The ash content of each sample was: 0.14, 0.12, 0.12, 0.11 and 0.16 %, respectively. Gelatinization process When starch is heated in excess water the amylopectin double helices dissociate, with accompanying loss of crystallinity, and the granules swell (by imbibing water). The starch granules can absorb water and an irreversible swelling takes place in this process. The data for this process are the “onset” or initial temperature (To), the “end set” or conclusion temperature (Tc), peak temperature (Tp) and gelatinization enthalpy (Hgel).These parameters as well as the viscosity are important for starch industry; they can reflect starch characteristics and play an important role in the application of the starches.

Cooking profile that includes a high viscosity peak followed by granule rupture and consequent cooking instability, ending with a moderate to low retro gradation tendency. In the case of the acid treatments, the viscosity values were inversely related with acid concentrations, as expected, but if one considers the behavior related with the temperature of reaction, with higher temperature (45 °C), the viscosity values were also higher than the reaction promoted at room temperature (25 °C). This was not expected as it is well

known that temperature increase generally is related with higher reaction rate. In an attempt to explain this behavior, it may be speculated that reagent degradation could occur at higher temperatures.

4. CONCLUSION

TG curves of cassava bagasse showed similar behavior; the samples showed three mass losses, the first due to dehydration, followed by stability and subsequently, decomposition (oxidation of starch and cellulose) in two consecutive steps. Each DTA event occurred with one endothermic (dehydration) followed by stability and two exothermic reactions, in agreement with the TG curves. Sample A, which was dried in a laboratory at 50 ºC showed gelatinisation process, viscosity and pasting properties in any granulometry. Sample B did not show the gelatinization process or pasting properties due to the industrial drying procedure that caused starch gelatinization as well as a slight darkening of the bagasse.

Simultaneous thermogravimetry and differential thermal analysis (TG-DTA) are techniques that allowed determining the hydration water, the main steps of decomposition and the ash content; all these results were in agreement with endo- or exothermic events and all the cassava starch show similar behavior. Differential scanning calorimetric (DSC) was used in the study of the starch gelatinization process; the major gelatinization enthalpy was found.

REFERENCES

[1] ABDUL-KHALIL, H.P.S., BHAT, A.H., YUSRA, A.F.I. 2012. Green composites from sustainable cellulose nanofibrils: A review. Carbohydr Polym, 87, 963-979.

[2] ALBERTON, C., COLMAN, T.A.D., SOUZA, J.A., OLIVEIRA, C.S., ANDRADE, M.M.P., SCHNITZLER, E. 2014. Thermal analysis, rheology, x-ray diffractometry and atomic force microscopy in the evaluation of binary mixtures of "starch-hydrocolloids". J Microbiol Biotech Food Sci., 3(4), 305-309.

[3] AOAC. 2010. Official Methods of Analysis of AOAC International. In: Association of Official Analytical Chemists 18th ed.

[4] BENINCA, C., COLMAN, T.A.D., LACERDA, L.G., FILHO, M.A.S.C., DEMIATE, I.M., BANNACH, G., SCHNITZLER, E. 2013. Thermal, rheological and structural behaviors of natural and modified cassava starch granules, with sodium hypochlorite solutions. J Therm Anal Calorim, 111(3), 2217-2222.

[5] CARTA, F.S., SOCCOL, C.R., RAMOS L.P., FONTANA, J.D. 1999. Production of fumaric acid by fermentation of enzymatic hydrolysates derived from cassava bagasse. Bioresour Technol, 68, 23-28. http://dx.doi.org/10.1016/S0960-8524(98)00074-1

[6] CEREDA, M. P. 2001. Propriedades Gerais do Amido. FUND. CARGILL 221 p, ISBN 85-88764-25-3.

[7] COLMAN, T.A.D., BICUDO, S.C.W., LACERDA, L.G., CARVALHO-FILHO, M.A.S., DEMIATE, I.M., BANNACH, G., SCHNITZLER, E. 2012. Characterization of wheat starch by thermoanalytical, rheological and atomic force microscopy techniques. Braz. J. Therm. Anal, 1, 62-65.

[8] CORDOBA, L.P., RIBEIRO, L.S., COLMAN, T.A.D., OLIVEIRA, C.S., ANDRADE, M.M.P., COSTA, F.J.O.G., SCHNITZLER, E. 2013. Effect of hydrochloric acid in different concentrations and temperatures up to some properties of organic cassava starch. Braz. J. Therm. Anal., 2(1), 6 – 11.

[9] COSTA, F.J.O.G., ALMEIDA, R.R., LACERDA, L.G., CARVALHO-FILHO, M.A.S., BANNACH, G., SCHNITZLER E. 2011. Thermoanalytical study of native cassava starch and treated with hydrogen peroxide. Aliment Nutr, 22(1), 7-15.

[10] FUKUOKA, M., OHTA, K.I., WATANABE, H. 2002. Determination of the terminal extent of starch gelatinization in a limited water system by DSC. J Food Eng, 53, 39-42.

[11] IAL. 2008. Métodos físicos e químicos para análise de alimentos. In: IAL. Normas Analíticas. (Instituto Adolfo Lutz, São Paulo), 5th ed.

[12] JUSZCZAK, L., FORTUNA, T., KROK, F. 2008. Non-contact atomic force microscopy of starch granules surface. Part I. Potato and tapioca starches. Starch/Staerke, 55, 1–7.

[13] KISELEVA, V. I., KRIVANDIN, A.V., FORNAL, J., BŁASZCZAK, W., JELIŃSKI, T., YURYEV, V. P. 2005.. Annealing of normal and mutant wheat starches. LM, SEM, DSC, and SAXS studies. Carbohydr Res, 340(1), 75–83.

[14] LACERDA, L.G., ALMEIDA, R.R., DEMIATE, I.M., CARVALHO-FILHO, M.A.S., VASCONCELOS, E.C., WOICIECHOWSKI, A.L., BANNACH, G., SCHNITZLER, E., SOCCOL, C.R. 2009. Thermoanalytical and Starch Content Evaluation of Cassava Bagasse as Agro-Industrial Residue. Braz Arch Biol Technol, 52, 143-150.

[15] PANDEY, A.; SOCCOL, C.R.; MITCHELL, D. 2000b. New developments in solid state fermentation: I-bioprocesses and products. Process Biochem (Amsterdam, Neth), 35(10), 1153–1169.

[16] PONGSAWATMANIT, R.; TEMSIRIPONG, T.; SUWONSICHON, T. 2007. Thermal and rheological properties of tapioca starch and xyloglucan mixtures in the presence of sucrose. Food Res Int, 40(2), 239–248.

[17] A.S.Syed Navaz & Dr.G.M. Kadhar Nawaz "Layer Orient Time Domain Density Estimation Technique Based Channel Assignment in Tree Structure Wireless Sensor Networks for Fast Data Collection" June - 2016, International Journal of Engineering and Technology, Vol No - 8, Issue No - 3, pp.–1506-1512.

[18] A.S.Syed Navaz, P.Jayalakshmi, N.Asha. "Optimization of Real-Time Video Over 3G Wireless Networks" September – 2015. International Journal of Applied Engineering Research, Vol No - 10, Issue No - 18, pp. 39724 – 39730.

[19] RICHARDSON, S., GORTON, L. 2003. Characterisation of the substituent distribution in starch and cellulose derivatives. Anal Chim Acta, 497, 27-65.

[20] SIVARAMAKRISHNAN, S.,GANGADHARAN, D., NAMPOOTHIRI, K.M., SOCCOL, C.R., PANDEY, A. 2007.Alpha amylase production by Aspergillus oryzae employing solid-state fermentation. J Sci Ind Res, 66(8), 621-626.

[21] SUN Q., SI, F., XIONG, L., CHU, L. 2013. Effect of dry heating with ionic gums on physicochemical properties of starch. Food Chem, 136(3-4),1421–1425.

[22] TEIXEIRA, E.M., RÓZ, A.L., CARVALHO, A.J.F., CURVELO, A.A.S. 2009. Preparation and characterisation of thermoplastic starches from cassava starch, cassava root and cassava bagasse. Macromol Symp, 229, 266-275.

[23] VILAPLANA, F.; HASJIM, J.; GILBERT, R. G. 2012. Amylose content in starches: Toward optimal definition and validating experimental methods. Carbohydr Polym, 88(1), 103–111. http://dx.doi.org/10.1016/j.carbpol.2011.11.072

[24] A.S.Syed Navaz & A.S.Syed Fiaz, "Load Balancing in P2P Networks using Random Walk Algorithm" March – 2015, International Journal of Science and Research, Vol No – 4, Issue No – 3, pp.2062-2066.

[25] A.S.Syed Navaz & Dr.G.M. Kadhar Nawaz "Flow Based Layer Selection Algorithm for Data Collection in Tree Structure Wireless Sensor Networks" March – 2016, International Journal of Applied Engineering Research, Vol No - 11, Issue No - 5, pp.–3359-3363.

[26] A.S.Syed Navaz & R.Barathiraja "Security Aspects of Mobile IP" Journal of Nano Science and Nano Technology (International), February 2014, Vol- 2, Issue – 3, pp - 237-240.

[27] A.S.Syed Navaz, S.Gopalakrishnan & R.Meena "Anomaly Detections in Internet Using Empirical Measures" February 2013, International Journal of Innovative Technology and Exploring Engineering, Vol 2 – Issue 3. pp. 58-61.

[28] A.S.Syed Navaz, H.Iyyappa Narayanan & R.Vinoth." Security Protocol Review Method Analyzer (SPRMAN)", August – 2013, International Journal of Advanced Studies in Computers, Science and Engineering, Vol No – 2, Issue No – 4, pp. 53-58.

[29] A.S.Syed Navaz, M.Ravi & T.Prabhu, "Preventing Disclosure of Sensitive Knowledge by Hiding Inference" February 2013, International Journal of Computer Applications, Vol 63 – No 1. pp. 32-38.

[30] Magkos F, Arvaniti F, Zampelas A. Organic food: buying more safety or juste peace of mind? A critical review of the literature. Crit. Rev. Food Sci. Nutr. 2006:46:23-56.

[31] Singh J, Kaur L, McCarthy OJ. Factors influencing the physico-chemical, morphological, thermal and rheological properties of some chemically modified starches for food applications - A review. Food Hydrocolloids 2007:21(1):1-22.

[32] Matsuguma LS, Lacerda LG, Schnitzler E, Carvalho-Filho MAS, Franco CML, Demiate IM. Characterization of native and oxidized starches of two varieties of Peruvian carrot (Acacia xanthorriza, B.) from two production areas of Paraná state, Brazil. Braz. Arch. Biol. Technol. 2009:52(3):701-713.

[33] P.Nazni & A.Jaganathan, STUDY ON MICROBIAL ANALYSIS OF STREET-VENDED FOOD SAMPLES SOLD IN SALEM DISTRICT, International Journal of Research in Biological Sciences, Vol -4, Issue – 3, August 2014. Pp. 75-78.

[34] P.Nazni & A.Jaganathan, STANDARDIZATION AND PROXIMATE ANALYSIS OF STREET FOODS SOLD IN SALEM DISTRICT, International Journal of Agricultural and Food Science, Vol -4, Issue – 3, August 2014. Pp. 94-99.

[35] Dr. A.Jaganathan, Human Nutrition to Prevent from Diet-Related Chronic Diseases, International Journal of Scientific Research, Vol -5, Issue – 8, August 2016. Pp. 1410-1413.

[36] Dr. A.Jaganathan, Production of Rice Flour and Peanut Paste in Yellow Cake, International Journal of Scientific Research, Vol -5, Issue – 9, September 2016. Pp. 597-600.

[37] Gomes da Costa FJO, Leivas CL, Waszczynskyj N, Godoi RCB, Helm CV, Colman TAD, Schnitzler E. Characterization of native starches of seeds of Araucaria angustifolia from four germplasm collections. Thermochim. Acta 2013:565(10):172-77.

[38] Colman TAD, Demiate IM, Schnitzler E. The effect of microwave radiation on some thermal, rheological and structural properties of cassava starch. J Therm. Anal. Calorim. 2014:115(3):2245-52.

Author Biography

Dr. A.Jaganathan received the B.Sc in HCM at Madras University, M.Sc HM at Annamalai University, M.A TM in Madurai Kamaraj University and his Ph.D in Periyar University. He has completed NET 2 times in Tourism Administration and Management & Home Science. He is having more than 20 years experience. Currently he is working as Principal / Secretary in Food Craft Institute, Hoshiarpur, Punjab, India. His Areas of interest are Food Science & hotel management.

S.Muguntha Kumar received his B.Sc from PGP College of Arts & Science and MBA from NBharathiyar University. Currently he is working as an Assistant Professor at Muthayammal College of Arts & Science, Rasipuram, Namakkal. India. His Areas of interest are Food Science & hotel management.