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Hin Banana Flour: A Revolutionary of Preventive Healthcare Trend in Food Industries

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The new trend of preventive healthcare through nurturing of wellness behavior makes health food products that aid weight control are highly in demand. Thirty percent of food businesses shift their normal operation towards functional food using unique ingredients to distinguish themselves from the competitors. Hin banana flour (HBF), a Thai local agricultural product, has been chosen to substitute wheat flour for making functional bakeries since it consisting high level of a powerful health benefit substance namely resistant starch. Sensory and nutrition of finished products i.e. protein, lipid, fiber and resistant starch were then evaluated and demonstrated that HBF bakery products contained dramatically high resistant starch range from 1.3-7.2 times compared to wheat products. Rapidly and slowly available glucose (RAG and SAG) of HBF and wheat products has also been investigated. The results indicated that HBF products possessed significantly less RAG and SAG value than those obtained from wheat with 17.9%-58.7% and 10.4%-52.9%, respectively, and the sensory testing was signified HBF products acceptance. Aforementioned qualities suggesting that HBF products help improve blood sugar control and can be highlighted as a revolutionary of healthy ingredients as well as a potential carbohydrate source for patients suffering from diabetes, obesity and chronic kidney disease.

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Introduction

Recently, the focusing on health care prevention becomes one of the most important issue of public health policy around the world. It has been extensively publicized that there is positive relation between diet behavior to intervention health problem or wellbeing. A lot of health-related factors had been investigated and revealed that individual life style or poor diet are keys role to elevate health problem which lead to severe sickness (Becker et al., 1977; Jayanti and Burns, 1998). Awareness on nutrition value has been one reason of shifting the normal diet pattern to healthy one, for example, low fat diet, low glycemic index or high fiber ingredient which, therefore, increasing the popularity of novel food with good nutritional properties. More and more new ingredients that claimed to be good for human health were introduced to the food market within years and one of them that acknowledge to promote human health is resistant starch (RS).

Resistant starch (RS) is non-digestible starch which classified into 4 type by its structure (Nugent, 2005). RS possessed properties similar to dietary fiber in the gastrointestinal tract and resulting the slow release of glucose into blood stream. This evident help diabetes patient in glucose regulation and promote more effective weight control for obesity (Higgins et al., 2004; King, 2004; Ohr, 2004). Bacteria inhabit in large intestine could ferment the residual of non-digested starch to produce short chain fatty acids such as acetate, propionate and butyrate which reduction the risk of colon cancer and encourage healthier colon cells (Higgin, 2013; Sekirov et al., 2010; Weaver et al., 1992 and Cumming and Macfarlane, 1991). In recent year, RS has been highly interest in food application both in term of health promotion and its functional properties (Sajilata et al., 2006). A number of studies also reported the other benefit of high resistant starch diet, i.e., potential of prebiotics, low glycemic effects, reduce cholesterol and triglyceride levels in blood, prevention of fat accumulation, reduce gall stone formation and enhancing minerals absorption (Han et al., 2003; Keenan et al., 2006; Lopez et al., 2001; Scholz-Ahrens et al., 2007; Mikušová et al., 2009; Nugent, 2005; Roberfroid, 2000; Sajilata et al., 2006; Sharma et al., 2008 and Younes et al., 1995). Functional properties and beneficial of resistant starch to human health are varied depending on the type of RS, source of RS and dose consumption (Buttriss and Stokes, 2008 and Nugent, 2005). Therefore, finding of new starch-base source of resistant starch with high in both quantity and quality will not only add value to food products but also extend the utility of resistant starch in medical field and offer the opportunity of public health improvement (Alexander, 1995; Wursch, 1999; Croghan, 2004; Topping et al., 2003). As many knew, RS present in various kind of food sources and green banana flour was considered to comprise high proportion of resistant starch type II (40-70%) which well recognized as a healthy food ingredient (Juárez-García et al., 2006; Vergara-Valencia et al., 2007).

Vatanasuchart et al., (2011) investigated resistant starch content and its digestibility of banana flours extracted from six Thai banana cultivars grown in Thailand. The results revealed that Hin banana flour containing the highest amount of RS with 68.1% and possessed the lowest digestibility and highest endothermic transition enthalpy (18.6 J/g) compared to others. Very high amount of RS and low digestibility properties contained in Hin banana flour pull the interest of authors to ongoing research about the application of Hin banana flour in food products. Unfortunately, knowledge of the application of RS derived from Hin Banana flour in starch base food products and its functional properties after processing are still unclear. Therefore, this research aimed to replace Hin banana flour to wheat flour for making 4 different types of popular bakery products and their nutrition value, functional ingredient and sensory evaluation were analyzed.

Materials and Methods

Material

Hin banana flour (HBF) has been kindly provided by Thai Orchids Lab Company Limited, Sampran, Nakornpathom, and repacked in aluminum foil bag and kept in dry place. The chemical composition and functional ingredient of HBF (RS) were measured by AOAC (1995). Commercial flour and other ingredients were purchased from local supermarket in Thailand. All chemical used in this study were analytical grade.

Making bakery products and their composition measurement

Four bakery products i.e., cookie, muffin, fruit cake and brownie were prepared using 100% HBF and 50:50 HBF:Wheat flour (WF) according to certain formula shown in Table 1 and procedure created by Puri Chunkajorn, lecturer of Siam Technology College. 100% wheat flour products has been used as control. Chemical composition of all products such as protein, fat, crude fiber and ash was analysed using AOAC method (1995). Rapid available glucose (RAG), slow avalilable glucose (SAG) and resistant starch remained in the products were determined according to Englyst (2002). Results were expressed by means of average values±standard deviation of two separate determinations.

Sensory evaluation and statistical analysis

Four bakery products have been subjected for sensory evaluation by 50 panelist age range from 17-21 years old. Panelist rated each sample for odor, taste, color, texture and overall acceptance on 9 point hedonic scale where 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) according to Stone and Sidel (1992). Scores were statistically analyzed on SPSS version 10.0 software for Windows using one-way analysis of variance (ANOVA) and *t*-test at significant level of $p<0.05$.

Table 1. Ingredient and method for making cookie, brownie, muffin and fruit cake

Recipe	Ingredient	Quantity	Cooking Method
Brownie	Butter	150 g	Baking, 170 ºC, 20 min
	Dark chocolate	125 g	
	Eggs	3	
	Sugar	250 g	
	Vanilla	5 g	
	Cake flour (wheat)	125 g	
	Cocoa powder	30 g	
Fruit Cake	Butter	150 g	Baking, 165 ºC, 45 min
	Shorting	50 g	
	Brown Sugar	200 g	
	Eggs	4	
	Mix spices	1/8 tsp	
	All-purpose flour (wheat)	200 g	
	Baking powder	½ tsp	
	Mix fruits	400 g	
	Cashew Nuts	100 g	
Muffin	Cake Flour (wheat)	300 g	Baking, 190/180 ºC, 30 min
	Baking Powder	12 g	
	Butter	400 g	
	Icing Sugar	170 g	
	Milk	30 g	
	Eggs	5	
	Salt	½ tsp	
Cookie	Butter	110 g	Baking, 170 ºC, 20 min
	Sugar	50 g	
	Brown sugar	60 g	
	Salt	¼ tsp	
	Egg	1	
	All-purpose flour (wheat)	180 g	
	Baking soda	½ tsp	
	Vanilla	½ tsp	
	White Chocolate	50 g	
	Macadamia nuts	100 g	
	Dried Apricot	50 g	

Recipe was written by Puri Chunkajorn

Results and Discussion

Chemical composition of Hin banana flour (HBF)

Moisture content, protein, ash, fat, total dietary fiber and resistant starch contained in prepared HBF was 6.7%, 3.5%, 1.1%, 1.3%, 78% and 68%, respectively. RS contained in HBF was similar to those reported by Vatanasuchart et al., (2011) and Bezerra et al., (2013). The low amount of protein also implication that Hin banana flour can be considered as an alternative ingredient for patients suffering from Chronic Kidney Disease (CKD) which need to control protein daily intake (National kidney foundation, 2010). Furthermore, HBF possessed very high amount of resistant starch and fiber which able to use in functional food in order to increase resistant starch intake to the sufficient amount especially for American and European that consume only 3-5 g/day and consider to be lower than recommendation dose (Institute of Medicine, 2001).

This also suggesting that even though HBF contained high amount of carbohydrate but most of them was non-digestible substance which allow the consumer to intake less glucose when compare to another commercial flour at the same dose and boost more nutrition for daily meal. Indeed, there is a great potential of using HBF as a new starch to increase nutrition value in all those starch-based food with very high resistant starch content and regarded as a healthy products (Aparicio et al., 2007; Rodriguez et al., 2008; Martinez et al., 2009).

Composition and functional properties of bakery products

To implement the application of HBF, researchers were prepared some bakery products namely brownie, fruit cake muffin and cookie which substitute wheat flour with Hin banana flour in the proportion of 50% and 100%. Those bakery products were chosen due to their different type of texture and baking protocol. Nutrition value of brownie, fruit cake, muffin and cookie made from 100% wheat flour (control), 100% HBF and 50:50 mixed of WF:HBF has been shown in Table 2.

From Table 2, there were significantly different in moisture and fat content derived from different recipes. However, comparing the same recipe produced from different flour shown slightly different of those value. Ash content in products received from 100% HBF shown significantly high comparing to the others. Bakery products made from 100% HBF presented similar amount of fiber than those produced from 50% HBF and wheat flour, respectively. It is noteworthy that all recipes made from 100% HBF contained very low amount of protein which some recipes shown more than 40% reduction. Lower amount of protein food was concerned to CKD patient stage 2 and 3 which affecting the decreasing of waste in blood and aid the kidney to work longer (National kidney foundation, 2010).

Since amount of resistant starch in food matrix is varied by the influences of many factors including quantity of initial RS, type of RS, how to process (cooking) and how to storage (Nugent, 2005 and Brown, 1996), hence, determination of RS and some functional properties such as rapid available glucose (RAG) and slow available glucose (SAG) has been performed and the results shown in table 3.

Table 2. Nutrition value of four bakery products made from different flour

Recipe/Type	Amount (% Dry basis)				
of flour	Moisture	Fat	Protein	Fiber	Ash
Brownie					
Control (100% WF)	13.76±0.29	32.10±0.73	9.89±0.03	13.90±0.47	1.18±0.13
HBF:WF (50:50)	18.67±0.20	36.81±0.09	9.44±0.02	12.09±0.03	1.47±0.16
HBF (100%)	19.65±0.84	34.49±0.23	8.15±0.06	15.50±0.64	1.75±0.08
Fruit cake					
Control (100% WF)	±25.251.14	±19.360.78	8.63±1.14	16.53±1.22	±1.430.18
HBF:WF (50:50)	±30.611.01	±15.580.24	8.50±1.23	±15.181.15	±1.740.11
HBF (100%)	±28.970.681	±18.500.25	5.83±1.22	14.81±0.46	±1.560.26
Muffin					
Control (100% WF)	20.96±0.41	44.21±0.92	13.05±0.12	15.70±0.76	1.41±0.32
HBF:WF (50:50)	20.42±0.30	40.02±0.60	11.61±0.30	14.28±0.37	1.44±0.08
HBF (100%)	19.17±0.08	43.15±0.24	7.51±0.35	14.31±0.59	2.01±0.13
Cookie					
Control (100% WF)	4.39±0.02	25.55±0.61	8.97±0.01	14.06±0.28	0.51±0.01
HBF:WF (50:50)	5.67±0.11	26.00±0.43	6.69±0.02	12.44±0.26	0.90±0.05
HBF (100%)	6.67±0.05	25.40±0.82	3.78±0.13	12.91±0.21	1.39±0.03

WF is Wheat flour, HBF is Hin banana flour

Table 3. Rapid available glucose (RAG), slow available glucose (SAG) and RS content of four bakery products made from different flour

Recipe/Type of flour	RAG (g/100g)	SAG (g/100g)	RS (g/100g)
Brownie			
Control (100% WF)	3.00±0.10	3.08±0.17	4.14±0.14
HBF:WF (50:50)	1.73±0.08	1.89±0.19	6.43±0.04
HBF (100%)	1.53±0.15	1.45±0.03	6.81±0.02
Fruit cake			
Control (100% WF)	11.92±1.14	5.17±0.78	0.86±0.25
HBF:WF (50:50)	7.84±1.01	5.39±0.24	3.32±0.26
HBF (100%)	8.92±0.681	3.25±0.25	6.21±0.22
Muffin			
Control (100% WF)	9.99±0.70	5.69±0.28	2.76±0.18
HBF:WF (50:50)	6.35±0.11	5.38±1.30	6.12±0.28
HBF (100%)	4.12±0.43	5.10±1.42	6.55±0.22
Cookie			
Control (100% WF)	3.55±0.00	4.66±0.49	12.77±0.34
HBF:WF (50:50)	3.52±0.25	4.60±0.12	14.84±0.21
HBF (100%)	2.91±0.30	4.97±0.75	16.47±0.46

WF is Wheat flour, HBF is Hin banana flour

RAG and SAG value were reflected to proportion of rapid digestible starch (RDS) and slow digestible starch (SDS), respectively (Englyst et al., 2000). It has been clear that proportion of RAG, SAG and RS of those respective bakery products produced from different type of flour were greatly different. Control samples (100% WF) show highest value of RAG while bakeries made from 100% HBF presented the lowest. HBF products possessed significantly less RAG and SAG value than those obtained from wheat with 17.9%-58.7% and 10.4%-52.9%, respectively. RS content in bakery products made from HBF were dramatically high range from 1.3-7.2 times compared to wheat products. It has been noticed that condition of baking, food matrix system and moisture content of bakery products influence the remaining of RS. Fruit cake that bake longer time in high temperature with excess amount of water (see Table 1 and 2) possessed least amount of RS and express highest RAG value. In contrast, cookie, low in water and less cooking time (see Table 1 and 2), shown lowest of RAG and present significantly high in RS. Evidence in this study supporting the finding of Englyst et al., (2000) which reported that the proportions of RAG, SAG, RDS, SDS and RS in foods can be controlled by food processing. From this study, it has been cleared that there was a possibility to replace wheat flour with HBF and achieve for producing high fiber gluten-free bakery with low GI property (Oluwatomiwa, 2008; Bamidele et al., 1990; Sarawong et al., 2014).

Table 4. Sensory test of four bakery products made from different flour

Recipe/Type of flour	Score				
	color	odor	taste	texture	overall acceptance
Brownie					
Control(100 %WF)	6.57±2.10^{ns}	6.67±1.63^{a}	6.77±1.97^{a}	6.67±2.07^{ns}	6.83±1.76^{a}
HBF:WF (50:50)	6.53±1.80^{ns}	5.80±1.71^{b}	6.67±1.73^{ab}	6.53±1.87^{ns}	6.57±1.76^{ab}
HBF (100%)	6.67±1.67^{ns}	5.70±1.77^{b}	5.93±1.76^{b}	5.83±2.25^{ns}	5.97±1.65^{b}
Fruit cake					
Control(100 %WF)	6.77±1.48^{a}	5.80±1.71^{a}	5.77±1.85^{a}	6.40±1.73^{a}	6.10±1.73^{a}
HBF:WF (50:50)	5.73±1.87^{b}	6.03±2.06^{a}	6.20±199^{a}	6.20±1.79^{a}	6.37±1.92^{a}
HBF (100%)	5.13±1.89^{b}	4.77±2.05^{b}	4.77±1.85^{b}	4.97±1.96^{b}	5.23±1.85^{b}
Muffin					
Control(100 % WF)	6.37±1.40^{a}	5.27±1.91^{a}	5.27±2.03^{a}	5.53±1.57^{a}	5.50±1.64^{a}
HBF:WF (50:50)	6.06±1.81^{a}	6.03±2.04^{a}	6.00±2.26^{a}	6.10±2.25^{a}	5.83±2.35^{a}
HBF (100%)	5.27±2.08^{b}	4.10±2.38^{b}	3.80±2.47^{b}	3.80±2.20^{b}	4.10±2.31^{b}
Cookie					
Control(100 % WF)	6.43±1.76^{a}	6.23±1.48^{a}	7.13±1.78^{a}	6.60±1.89^{a}	6.73±1.89^{a}
HBF:WF (50:50)	6.40±1.63^{a}	5.90±1.47^{a}	5.83±1.97^{b}	5.80±2.04a^{b}	6.13±1.80^{a}
HBF (100%)	4.33±1.79^{b}	5.10±2.04^{b}	4.87±2.32^{c}	5.07±2.41^{b}	5.00±2.10^{b}

WF is Wheat flour, HBF is Hin banana flour; Different superscript letters in a column indicate significant differences ($P \leq 0.05$); ns designated as not significant.

Sensory evaluation of bakery products

Table 4 shown the results of sensory test from all respective bakeries in this study and all products made from HBF possessed darker color than control one. The finding expressed that overall acceptance of bakery produced from WF and HBF:WF (50:50) was not significantly different with like slightly score (6) while bakery made from 100% HBF shown significantly lower acceptance with neither like or dislike score (5) or even dislike slightly score (4) for muffin. Interestingly, sensory test derived from brownie made from 100% HBF found not significantly different in color and texture compared to control. This suggesting that substitute wheat flour with HBF in the ratio of 1:1 did not affect the sensory and appearance of products to consumer. Unfortunately, to completely replace wheat flour with HBF for these bakery products need more research and development to improve their texture in order to commercially acceptance.

Considering the result of this experiment and researches on utilization of banana flour in bread making, noodles and other starch base products, it could sentence that HBF is the novel ingredient with low digestibility, able to use as wheat substitution and be a future of health food industry or food for some disease patients (Olaoye et al., 2006; Juarez-Garcia et al., 2006).

Conclusions

In summarize, HBF is a new interesting food ingredient since it contained large quantity of RS and tend to provide low glycemic index and high nutrition value as a plus which promote a great health benefits colon cancer, diabetes or obesity and add value to “niche” food products in particular. HBF are not only good to go for making starch-based food i.e., bakery, noodles, soup etc. for health consciousness people but also suitable for used to make patient’s food suffering from CKD or diabetes type II and lift up their life quality from greatly change of their diet including improve their social and psychological condition. Therefore, to research more in the application of HBF in various starch-based food is the way to expand the utilization of HBF and it will not be an over claim to say that HBF is a revolutionary of healthy ingredients in the future food industry.

Conflict of Interest

All the authors declare that they have no conflict of interest.

References

1 Alexander, R.J. (1995). Resistant starch –new ingredient for the food industry. Cereal Food World, 40(6), 455-458.

2 Aparicio-Saguilán, A., Flores-Huicochea, E., Tovar, J., García-Suárez, F., Gutiérrez-Meraza, F. and Bello-Pérez, L.A. (2005). Resistant starch-

rich powders prepared by autoclaving of native and lintnerized banana starch: Partial characterization. Starch/Stärke, 57, 405-412.
3 Association of Official Analytical Chemists (AOAC). (1995). Official Method of Analysis. 15th edition The Association of Official Agricultural Chemists. Verginia.
4 Bamidele, E.A. (1990). Cardoso AO and O Olaofe Rheology and baking potential of wheat/plantain composite flour. Journal of the Science of Food and Agriculture, 51(3), 421-424.
5 Becker, M. H., Maiman, L. A., Kirscht, J. P., Haefner, D. P. and Drachman, R. H. (1977). The Health Belief Model and Prediction of Dietary Compliance: A Field Experiment. Journal of Health and Social Behavior, 18(4), 348-366.
6 Bezerra, C.V., Rodrigues, A.N., Amante, E.R. and Meller, L.H. Nutritional Potential of Green Banana Flour Obtained by Drying in Spouted Bed. Rev. Bras. Frutic., 35(4), 1140-1146.
7 Brown. (1996). complex carbohydrates and resistant starch. Nutrition Reviews, 54(11): s5155-19.
8 Buttriss, J.L. and Stokes, C.S. (2008). Dietary fibre and health: An overview British Nutrition Foundation. Nutrition Bulletin, 33, 186-200.
9 Croghan, M. (2004). Resistant starch-a better for you carbohydrate. Proceedings for Food Ingredients Asia Conference: Consumer awareness on Healthy and functional ingredients. September 16-17. Bangkok.
10 Cummings JH, MacFarlane GT. (1991). The control and consequences of bacterial fermentation in the human colon. J Appl Bacteriol, 70, 443-459.
11 Englyst, H. N, Kingman, S. M. and Cummings, J. H. (1992). Classification and measurement of nutritionally important starch fractions. Eur. J. Clin. Nutr. 46, 33-50.
12 Garcia-Segovia, P., Andres-Bello A. and Martinez-Monzo J. (2007) Effect of cooking method on mechanical properties, color and structure of beef muscle (M. pectoralis). Journal of Food Engineering, 80, 813-821.
13 Han, K. H., Fukushima, M., Kato, T., Kojima, M., Ohba, K., Shimada, K., Sekikawa, M. and Nakano, M. (2003). Enzyme-resistant fractions of beans lowered serum cholesterol and increased sterol excretions and hepatic mRNA levels in rats. Lipids, 38(9), 919-24.
14 Higgins, J. A., Higbee, D. R., Donahoo, W.T., Brown, I. L., Bell, M. L. and Bessesen, D. H. (2004). Resistant starch consumption promotes lipid oxidation. Nutr. Metab., 1(8).
15 H. Stone, J.L. Sidel. (1992). Sensory Evaluation Practices. Academic, San Diego.
16 Institute of Medicine. (2001). Dietary Reference Intakes: Proposed Definition of Dietary Fiber. Washington, DC: National Academies Press.
17 Jayanti, R. K. and Burns, A. C. (1998). The antecedents of preventive health care behavior: An empirical study. Journal of the Academy of Marketing Science, 26(6).
18 Juarez-Garcia, E., Agama-Acevedo, E., Sa´Yago-Ayerdi, S.G. and Rodri´guez-Ambriz, S.L. (2006). Composition, Digestibility and Application in Bread making of Banana Flour. Plant Foods for Human Nutrition, 61, 131-137.
19 Keenan, M.J., Zhou, J., Mccutcheon, K.L., Raggio, A.M., Bateman, H.G. Todd, E., et al., (2006). Effects of resistant starch, a non-digestible fermentable fiber, on reducing body fat Obesity, 14, 1523-1534.
20 King, J.M. (2004). Resistant starch from rice, a new source of dietary fiber. Available source: http:/www.resistantstarch.com.
21 Lopez, H.W., Levrat-Verny, M.A., Coudray, C., Besson, C., Krespine, V. and Messager, A. (2001). Class 2 resistant starches lower plasma and liver lipids and improve mineral retention in rats. Journal of Nutrition, 131, 1283-1289.
22 Martinez-Flores, H.E., Chang, Y.K., Martinez-Bustos, F. and Sgarbierid, V. (2004). Effect of high fiber products on blood lipids and lipoproteins in hamsters. Nutrition research, 24(1), 85-93.
23 Mikušová, L., Šturdík, E., Mošovská, S., Brindzová, L., and Mikulajová, A. (2009). Development of new bakery products with high dietary fibre content and antioxidant activity for obesity prevention. In Proceedings of 4th international dietary fibre conference (p. 185). Vienna, Austria: International association for cereal science and technology (ICC).
24 National kidney foundation. (2010). Nutrition and Kidney Chronic Disease (Stage 1-4). Available source: http:/www.kidney.org.
25 Nugent, A.P. (2005). Health properties of resistant starch. British Nutrition Foundation, Nutrition Bulletin, 30, 27-54.
26 Ohr, M.L. (2004). Fortifying with fiber. Food Tech., 58 (2), 71-75.
27 Olaoye, O.A., Onilude, A.A. and Idowu, O.A. (2006) Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. African Journal of Biotechnology, 5(11), 1102-1106.
28 Oluwatomiwa, T.A. (2008). Economic analysis of plantain in Ondo West and Ondo East Local Government Area of Ondo State. Unpublished MSc Agricultural Economic Thesis, University of Ibadan, Nigeria.
29 Roberfroid, M.B. (2000). Prebiotics and probiotics: Are they functional foods? American Journal of clinical Nutrition, 71(6), 1682-1687.
30 Rodríguez, S.L., Islas, J.J., Agama, E., Tovar, J. and Bello, L.A. (2008). Characterization of a fibre-rich powder prepared by liquefaction of unripe banana flour. Food Chemistry, 107, 1515-1521.
31 Sajilata, M.G., Singhal, R.S. and Kulkarni, P.R. (2006). Resistant starch-A Review. Comprehensive reviews in food science and food safety, 5(1), 1-17.
32 Sarawong, C., Gutierrez, Z.R., Berghoef, E. and Schoenlechner, R. (2014). Effect of green plantain flour addition to gluten-free bread and resistant starch content. International Journal of Food Science and Technology.
33 Scholz-Ahrens, E., Ade, P., Marten, B., Weber, P., Timm, W., Yahya, A., et al., (2007). Prebiotics, probiotics, and synbiotics affect mineral absorption, bone mineral content, and bone structure. Journal of Nutrition, 137, 838-846.
34 Sekirov I, et al., Physiol Rev. (2010). 859-904.
35 Sharma, A., Yadav, B.S. and Ritika. (2008). Resistant starch: Physiological roles and food applications. Food Reviews International, 24, 193-234.
36 Topping, D.L., Anthony, M.F. and Bird, F. (2003). Resistant starch as prebiotic and synbiotic: State of the art. Proceedings of the Nutrition Society, 62, 171-176.
37 Vatanasuchart, N, Niyomwit, B. and Wongkrajang, K. (2009). Resistant Starch Contents and the in Vitro Starch Digestibility of Thai Starchy Foods. Kasetsart J. (Nat. Sci.), 43, 178-186.
38 Vatanasuchart, N, Niyomwit, B. and Wongkrajang, K. (2012). Resistant starch content, in vitro starch digestibility and physico-chemical properties of flour and starch from Thai bananas. Maejo International Journal of Science and Technology, 6(02), 259-271.
39 Vergara-Valencia N., Granados-Perez E., Agama-Aceved, E., Tovar J., Ruales J. and Bello-Perez, L.A. (2007). Fibre concentrate from mango fruit: Characterization; associated antioxidant capacity and application as a bakery product ingredient. LWT-Food Science and Technology, 40, 722-729.
40 Weaver GA, Krause JA, Miller TL, Wolin MJ. (1992). Cornstarch fermentation by the colonic microbial community yields more butyrate than does cabbage fermentation; cornstarch fermentation rates correlate negatively with methanogenesis. Am J Clin Nutr, 55, 70-77.
41 Wursch, P. (1999). Resistant starch, 385-394. In S.S. Cho, P. Prosky and M. Dreher, (eds.). Complex Carbohydrates in Foods. Marcel Dekker, Inc. New York.
Younes, H., Levrat, M.A., Demige, C. and Remesy, C. (1995). Resistant starch is more effective than cholestyramine as a lipid-lowering agent in the rat. Lipids, 30, 847-853.