Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 25, No. (1) : 2023 : 165-171

ISSN-0972-3005

DOI No.: http://doi.org/10.53550/AJMBES.2023.v25i01.027

PINEAPPLE POMACE AS A SOURCE OF DIETARY FIBER AND ITS EFFECT ON THE RHEOLOGICAL CHARACTERISTICS OF DOUGH IN PASTA MAKING

KADAM SHAHAJI MUNJAJI[1], AJAY KUMAR SINGH[2], ANISHA FRANCIS[1] AND JOHN DIAMOND RAJ[3]

Department of Processing and Food Engineering,
Vaugh Institute of Agricultural Engineering & Technology,
Sam Higginbottom University of Agriculture, Technology& Sciences, Prayagraj 211 007, U.P., India

(Received 10 August, 2022; Accepted 22 October, 2022)

Key words: *Pineapple pomace, Farinograph; Extensograph characteristics Pasta, Dietary fibre.*

Abstract– Pineapple pomace, a by-product of pineapple juice industry, is a rich source of fibre. Pineapple pomace procured from fruit juice industry, contained 10.8 % moisture, 0.5% ash and 51.1 % of dietary fibre. Finely ground pineapple pomace was incorporated in semolina at 5 %, 10 %, 15 %, 20 % and 25 % levels and studied for rheological characteristics. Rheological characteristics such as water absorption, proving time, development time, extensibility, and tolerance index were determined using the Farinograph and Extensograph. Barbender, Water absorption (500 B.U.) values ranged from 49.5 % to 57.1 %, and water absorption (14.0 %) values ranged from 47.2 % to 54.8 %. For samples T1, T2, T3, T4, and T5, the development times for the flour blend formulations were 4.7 min, 5.0 min, 6.3 min 6.8 min and 7.5 min, respectively. With the addition of pineapple pomace, the tolerance index improved from sample T1 to T5, i.e. from 57.5 BU to 94.0 BU. Extensograph readings were recorded at curves that represented proving times of 30, 60 and 90 minutes. With an increase in proving time, the energy area decreased and extension resistance increased. All the samples ratio values were between the ranges of 23 and 105 the outcomes clearly demonstrated that the use of pineapple pomace powder increased the rheological characteristics and the quality of the composite flour dough indicating that pineapple pomace can serve as a good source of dietary fibre.

INTRODUCTION

In 2011 (FAO, 2013), there were 21.8 million tonnes of pineapples produced worldwide. The majority of this production is utilised to make jams, concentrates, juices, and fruit salads. The majority of the byproducts produced during processing are peel and pomace, which together make up around 25–35% of the fruit weight. Since the majority of these byproducts have no clear end use, they might be disposed of improperly and cause environmental problems. In order to increase the economics and sustainability of the process, it is crucial to utilize industrial waste.

All of these effects of dietary fibre intake have led to a trend in the development of products that is enhanced with fibre or make particular fibre claims. The Food and Drug Administration (FDA 2013) states that a product must have, in a serving size, 20% or more fibre and 10% to 19% of the recommended daily value for dietary fibre in order to make the claims "high source of fibre" and "excellent source of fibre," (Selani *et al.*, 2014) (Sadal *et al.,* 2018).

One of the most significant economic areas in the tropical fruit sector is the pineapple (Ananas comosus L.) processing industry. But it produces a significant quantity of waste—up to 30 tonnes for every 100 tonnes of processed fruit produced each day—that is used as animal feed. These by-products have recently been proposed as a source of dietary fibre (DF) and bioactive substances including Carotenoids and polyphones, which have been acknowledged for their biological activity as potent

([1]Research Scholar, [2&3]Assistant Professor)

antioxidants (Martinez *et al*., 2012; Selani *et al*., 2014). While DF enhances gastrointestinal and physiological processes and offers numerous advantages to human health (Efigenia *et al.,* 2018).

It is expected that residual fruit and waste materials would be used in future industrial operations including fermentation and the extraction of bioactive components. The usage of waste from the dairy, meat, and fruit and vegetable sectors has been the subject of numerous studies. In this end, numerous initiatives have been made to make use of pineapple wastes collected from various sources (Upadhyay *et al.,* 2010).

Approximately 25–35% of the fruit's weight is wasted during processing in the form of byproducts, the majority of which being peel and pomace (Larrauri *et al.,* 1997). Since the majority of these byproducts have no clear end use, they might be disposed of improperly and cause environmental problems. In order to increase the economics and sustainability of the process, it is crucial to utilize industrial waste.

According to (Martnez *et al.,* 2012), the fibre content of pineapple byproducts (peel and heart) is about 76%, with 99.2% of it being the insoluble fraction and 0.8% the soluble portion. Pineapple pomace can be used as a possible food additive to enhance the nutritional value of foods because it contains valuable amounts of dietary fibre (Selan *et al.,* 2014).

Pasta, hot breakfast cereal, couscous, and baby food are all created from semolina, a granular endosperm product made by milling durum wheat. Semolina's suitability for making pasta is determined by its granulation, moisture content, sand content, colour, gluten quality, ash content, cooking test, falling number, and speck count. Semolina flecks that are brown and black appear as undesirable flecks in completed pasta. Specks made by germ, bran, discolored wheat kernels; diseased wheat seeds, foreign objects, and stones that escaped washing or purification are some of the contaminants that can be found in finished pasta (Awoyale *et al.,* 2021).

Pasta is the Italian term for dough. Italian-style extruded foods like spaghetti and lasagna are referred to as pasta. It is a dish from ancient times that consists of dough that has been shaped for cooking using an extruder or a stamp. Over 14 million tonnes of pasta were produced worldwide in 2014, according to estimates. Pasta production and consumption in the world have historically been dominated by Italy. Because it is simpler, more palatable, and has a longer shelf life than other bakery items like breads and buns, pasta is consumed widely worldwide (Nilusha *et al.,* 2019).

The consumption of pasta, the second-most popular food in the world, grew by 2 million tonnes in 2014 over 2013. (International Pasta Organization Survey, 2015) Due to its adaptability, affordability, simplicity of preparation, and nutritional value, pasta is a widely consumed food item. Pasta is a nutritious food that has nearly little fat and is high in protein, minerals, and carbohydrates (Desai *et al.,* 2017).

MATERIALS AND METHODS

Materials

All the raw material was collected from the local market in Prayagraj. The present study was carried out in the research lab Department of Processing and Food Engineering Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The main objective of this experiment is to study the drying behavior of Pineapple pomace under different drying techniques using tray dryer and hot air oven dryer. Matured pineapple was purchased from the local market of Prayagraj (U.P.). The trials were carried out at Department of Agricultural Process Engineering, Dr. AS College of Agricultural Engg and Technology, MPKV, Rahuri, Dist. Ahmadnagar, Maharashtra.

Methods

Farinographic Assay

The resistance of the dough to the action of the paddles used to mix the dough is measured using a Farinograph to determine the rheological properties of the flour. After being weighed, a 300 g sample of flour with 14% moisture content was added to the corresponding farinograph mixing bowl. The flour was blended with water from a burette to make dough. The flour was mixed with 1.5 g/100 g salt and a 300 g Brabender Farinograph (Brabender GmbH and Co. KG, Germany) was used to carry out the test in accordance with the recommended procedure (AACC, 2000). The Farinogram provided information on a number of parameters, including the quantity of water required to create a dough consistency of 500 BU (water absorption), the time required to develop that consistency (development time), the time the dough remained at that consistency (dough stability time), and the amount of softening that occurred after 12 minutes.

Extensographic Assay

By measuring the force required to stretch the dough with a hook until it breaks, an Extensograph may measure the stretching qualities of the dough, including its extensibility and resistance to extension. The features of flours prepared from amaranth, rice, and raw banana were examined in this study using an Extensograph-E (Brabender GmbH & Co. KG). In accordance with the standard method (AACC, 2000), this provided information on the energy value (area under the curve, cm^2), the resistance to extension (R, BU), the dough extensibility (E, mm), and the R/E value at 30, 60, and 90 min.

Statistical Analysis

Unless otherwise noted, each analysis had been done in triplicate. Analyzing variance in one way (ANOVA) was used to evaluate statistical significance, and results were reported as the mean standard deviation.

RESULTS AND DISCUSSION

Farinograph characteristics of blended flour

A farinograph is a suitable tool for evaluating the dough's ability to mix. It also has been used to assess the dough characteristics of flours in the bakery and milling sectors. An efficient way to forecast processing behavior and manage the food item's quality is to characterize the rheological characteristics of dough.

According to Table 1, (Tray Dryer), the water absorption (500 B.U.) was 47.9 % and water absorption (14.0 %) was 45.6 % for T_0 sample. Whereas it is 49.5% and 47.2 % for sample T1 respectively. According to table 2, (Hot air oven) water absorption (500 B.U) was 50.0 % and water absorption (14.0 %) 47.7 T1 sample. Whereas it is 53.8 % and 51.5 % for sample T2 respectively. For the composite flour blend, the water absorption values varies with addition of pineapple pomace powder in the flour blend from 50.8 % to 57.1 % for WA (500 B.U.) and 48.5 % to 54.8 % for WA (14.0 %) for table 1 tray dryer and 54.3 % to 56.9 % for WA (500 B.U.) Table 2. The amount of water needed to get typical dough which has consistency of 500 B.U. at the curve's peak is represented by water absorption. The curve's centre will not reach the 500 B.U. line with much more water, but it will cross that line with very little water. This suggests a strong aûnity between dietary fiber and water during dough mixing (Kim *et al.,* 2013) caused by the hydrogen bonds resulting from the interaction of the hydroxyl groups within the structure of the DF component with water reported by (Sudha *et al.,* 2007; Kohajdová *et al.,* 2009, Turksoy *et al.,* 2011). As per the (Munoz and Garcia, 2015), the water absorption is directly proportional to fiber content of the dough. The samples with higher fiber content have a greater diffusion coefficient, due to the fact that absorption of water is higher. Therefore, as the fiber content of dough increases with the addition of pineapple pomace powder, the water absorption also increases.

The development time is the interval between the initial water addition and the moment the dough reaches its maximum torque. The water hydrates the components of the flour during this mixing stage, resulting in the development of the dough. As per Table 1, Sample T0 had the minimum development time of 4.3 minute whereas sample T1 had 4.7 minutes. The development time varies with the replacement of pineapple pomace powder with semolina but it does not have much impact on formulations of flour blends. Development time for

Table 1. Farinograph characteristics of Pasta Dough Comprising Pineapple Pomace Powder (Tray Dryer) and Semolina

Sample	Moisture Content (%)	W.A. (500 BU)	W.A (14.0%)	Development Time (Min)	Stability (Min)	Tolerace index (BU)	Time to breakdown (Min)	Farinograph quality No.
T_0	12.0	47.9	45.6	4.3	1.8	40.0	5.4	45
T_1	12.0	49.5	47.2	4.7	1.9	57.5	5.6	50
T_2	12.0	50.8	48.5	5.0	2.1	65.7	6.0	54
T_3	12.0	51.3	49.0	6.3	2.6	73.5	7.4	56
T_4	12.0	51.6	49.3	6.8	3.7	81.0	8.3	60
T_5	12.0	57.1	54.8	7.5	3.8	94.0	9.5	84

the formulations of flour blends is 5.0 min, 6.3 min, 6.8 min and 7.5 min for sample T2, T3, T4 and T5 respectively. As per Table 2 sample T1 had the minimum development time of 5.0 minute whereas sample T2 had 5.2 minutes. The development time varies with the replacement of pineapple pomace powder with semolina but it does not have much impact on formulations of flour blends. Development time for the formulations of flour blends is 5.5 min, 7.2 min, and 9.4 min for sample T3, T4 and T5 respectively. (Sudha *et al.*, 2007) said that the development time of the dough depends on the fiber content of flour. They stated that, an increase in the dough development time indicates that an increase in bre content in the blends has slowed the rate of hydration and development of gluten. Also according to (Usman *et al.*, 2020), dough development time increased due to late gluten development as more water is absorbed by the fiber and starch portion of the composite flour. Hence here also the development time goes increased as the fiber content of the samples increased with addition of pineapple pomace powder.

A greater score indicates a stronger dough since stability time measures how strong the flour is. As per Table 1, the T5 sample showed the highest stability 3.8 min as compared to T0 which showed the lowest stability i.e., 1.8 min. Stability of the flour blend goes increase from T1 to T5 as the pineapple pomace mix with semolina The percentage of pineapple pomace powder increases from sample T1 to T5 and respectively increase the dough stability. According to Table 2, T5 sample showed the highest stability 4.7 min as compared to T1 which showed the lowest stability i.e., 2.0 min. Stability of the flour blend goes increase from T1 to T5 as the pineapple pomace mix with semolina. The percentage of pineapple pomace powder increases

Table 2. Farinograph characteristics of Pasta Dough Comprising Pineapple Pomace Powder (Hot air oven) and Semolina

Sample	Moisture Content (%)	W.A. (500 BU)	W.A (14.0 %)	Development Time (Min)	Stability (Min)	Tolerane index (BU)	Time to breakdown (Min)	Farinograph quality No.
T_1	12.0	50.0	47.7	5.0	2.0	45.3	6.4	64
T_2	12.0	53.8	51.5	5.2	2.2	50.7	6.6	66
T_3	12.0	54.3	52.0	5.5	2.6	67.8	7.8	78
T_4	12.0	57.2	54.6	7.2	3.0	73.7	7.9	79
T_5	12.0	56.9	54.9	9.4	4.7	88.5	10.4	104

Table 3. Extensograph characteristics of Pasta Dough Comprising Pineapple Pomace Powder (Tray Dryer) and Semolina

Samples	Proving time (Min)	Water absorption (%)	Energy (cm^2)	Resistence to extension (BU)	Extensibility (mm)	Maximum resistance (BU)	Ratio Number
$\mathbf{T_0}$	30	48	105	23	114	451	4.0
	60		89	25	133	534	4.0
	90		76	27	110	519	4.5
$\mathbf{T_1}$	30	50	67	30	65	54	4.2
	60		60	33	63	99	5.3
	90		57	35	60	66	3.7
$\mathbf{T_2}$	30	48	53	39	53	276	7.0
	60		50	44	50	269	5.9
	90		49	50	49	638	13.0
$\mathbf{T_3}$	30	48	43	57	43	533	10.7
	60		40	67	40	276	5.6
	90		35	74	37	684	13.0
$\mathbf{T_4}$	30	48	30	77	34	783	19.7
	60		28	80	32	843	23.2
	90		27	87	30	918	23.5
$\mathbf{T_5}$	30	48	23	93	25	1638	42.6
	60		20	96	20	1638	46.0
	90		18	105	19	1638	47.0

from sample T1 to T5 and respectively increases the dough stability. (Kohajdová *et al.,* 2014), explained that dough containing pineapple pomace powder exhibits higher dough stability than the control sample. As the pineapple pomace powder increases, then the dough stability also increases eventually.

The change in barbender units recorded 5 minutes just after apex of the curve is attained is the mixing tolerance index. According to Table 1, Tolerance index was higher for T5 sample. It increased from sample T1 to T5 with addition of pineapple pomace powder i.e., from 57.05 BU to 94 BU. According to table 2, Tolerance index was higher for T5 sample. It increased from sample T1 to T5 with addition of pineapple pomace powder i.e., from 45.3 BU to 88.5 BU. This happened due to the unavailability of gluten protein in the formulations. With the increasing amount of pineapple pomace powder in the blend, the starch and fiber content also increased. In the result, there was no interaction between starch and gluten, hence resulted in higher MTI. As per the (Kundu *et al.,* 2012).

Time to breakdown is the period of time, measured to the closest half-minute, as from beginning of the blending process to a reduction of 30 B.U. from the peak point. According to Table 1, sample T5 has highest breakdown time of 9.5 min and sample T0 (semolina) has lowest breakdown time i.e., 5.4 min. As the proportion of pineapple pomace powder increased in the formulations the respective time to breakdown of dough also increases from sample T1 to T5. The time required to breakdown of dough was 5.4, 5.6, 6.0, 7.4, 8.3 and 9.5 min for sample T0, T1, T2, T3, T4 and T5 respectively. According to Table 2, sample T5 has highest breakdown time of 10.4 min and sample T1 (pineapple pomace) has lowest breakdown time i.e., 6.4 min. As the proportion of pineapple pomace powder increased in the formulations the respective time to breakdown of dough also increases from sample T1 to T5. The time required to breakdown of dough was 6.4, 6.6, 7.8, 7.9 and 10.4 min for sample T1, T2, T3, T4 and T5 respectively. With increasing starch content (pineapple pomace powder) of dough, the breakdown time also reduces.

A common indicator called the farinograph quality number was developed by the Barbender TM Company. According to Table 1, the farinograph quality number was also higher for sample T1 and T5 with related to breakdown time. The farinograph quality number for sample T0, T1, T2, T3, T4 and T5 was 45, 50, 54, 56, 60 and 84 respectively. According to Table 2, the farinograph quality number was also higher for sample T2 and T5 with related to breakdown time. The farinograph quality number for sample T1, T2, T3, T4 and T5 was 64, 66, 78, 79 and 104 respectively.

Extensograph characteristics of composite flour blend

Extensibility, which is an unaxial load extension curve of the dough test piece subjected to measure stretching of the dough, is an indicator of good dough handling skills. Extensograph analysis offers

Table 4. Extensograph characteristics of Pasta Dough Comprising Pineapple Pomace Powder (Hot air oven) and Semolina

Samples	Proving time (Min)	Water absorption (%)	Energy (cm^2)	Resistence to extension (BU)	Extensibility (mm)	Maximum resistance (BU)	Ratio Number
T_1	30	48	58	32	67	163	4.3
	60		56	35	64	149	3.6
	90		53	38	60	128	3.8
T_2	30	48	48	41	57	327	6.9
	60		46	44	53	327	7.6
	90		38	47	50	327	6.6
T_3	30	48	34	53	47	708	12.9
	60		30	58	43	787	16.8
	90		28	64	38	900	20.1
T_4	30	48	25	72	36	1449	36.4
	60		23	79	30	1302	37.3
	90		20	83	28	1484	38.6
T_5	30	48	18	92	26	1540	43.0
	60		17	96	23	1350	45.7
	90		15	106	15	1248	47.9

information on the visco- elastic behaviour of dough and assesses its extensibility and resistance to stretching. A combination of good resistance and good flexibility results in dough with desirable properties. The rheological properties of the dough samples were evaluated using the extensograph (Barbender, Duisburg, Germany), including their resistance to extension (BU), extensibility (mm), and maximum energy required for dough extension. The ratio number might be calculated from various factors.

The samples' values are listed in Table 3. This extensograph curves at 30, 60, and 90 minutes of proving time are displayed. The area beneath the curve i.e., energy value (cm^2) ranged between 18 to 105 cm^2 for samples T0 and T5. The energy area goes decreased as the proving time increases in all the samples. The resistance to extension was higher for T5 i.e. 105 BU at resting time of 90 min. It is lower for the sample T0 and values as 23, 25 and 27 at 30 min, 60 min and 90 min of proving time respectively. The resistance to extension increased from samples T1 to T5 with respect to all mentioned proving time. For the T0, the extensibility also higher range between 44 and 51 and it was less for the T5 ranged between 30 and 35. This is due to the increase in starch content of pineapple pomace powder. The resistance to extension is directly proportional to the starch content of the flour blend (Hackenberg *et al.*, 2019).

Similarly in Table 4, this extensograph curves at 30, 60, and 90 minutes of proving time are displayed. The area beneath the curve i.e., energy value (cm^2) ranged between 32 to 47 cm^2 for samples T1 and T2. The energy area goes decreased as the proving time increases in all the samples. The resistance to extension was higher for T5 i.e. 106 BU at resting time of 90 min. It is lower for the sample T0 and values as 23, 25 and 27 at 30 min, 60 min and 90 min of proving time respectively. For the T0, the extensibility also higher range between 114 and 110 and it was less for the T5 ranged between 26 and 15 similar results was found by Moazzezi *et al.,* 2012).

Similarly in Table 3, the maximum resistance to extension was higher for T5 i.e. 1638, at proving time of 30, 60 and 90 minutes. After T5, it was higher in sample T4 which is ranged from 918 to 783. The maximum resistance to extension also goes decreased with respect to increased proving time. It was less for the sample T1, i.e. 163 BU at 30, 149 BU at 60 and 128 BU at 90 minutes. According to Chen *et al.*, (1988a).

Similarly in Table 4, the maximum resistance to extension was higher for T5 i.e. 1540, 1350 and 1248 at proving time of 30, 60 and 90 minutes. After T5, it was higher in sample T4 which is ranged from 1484 to 1449. The maximum resistance to extension also goes decreased with respect to increased proving time. It was less for the sample T1, i.e. 54 BU at 30, 99 BU at 60 and 66 BU at 90 minutes.

Ratio number (R/E) is a comprehensive indication of extensibility and resistance in flour, a higher value signifying stronger resistance and lower extensibility. Harder dough smaller the expansion According to Table 3, the ratio number for all the samples were ranged between 4.0 and 47.0 From the observations, it was shown that the sample T0 and T1 has lower R/E ratio, resulting in strongly acceptable dough formulation.

Ratio number (R/E) is a comprehensive indication of extensibility and resistance in flour, a higher value signifying stronger resistance and lower extensibility. Harder dough smaller the expansion According to Table 4, the ratio number for all the samples were ranged between 3.6 and 47.9 From the observations, it was shown that the sample T1 and T2 has lower R/E ratio, resulting in strongly acceptable dough formulation.

CONCLUSION

The influence of partial addition of pineapple pomace powder on the dough rheological characteristics and quality were investigated. The findings showed that the addition of pineapple pomace powder significantly affected dough rheological characteristics as measured by farinograph and especially extensograph. Based on the analysis of farinograph, the stability time showed the time between 0.2 min and 1.0 min. Compared to the controlled sample, the tolerance index and time to breakdown of dough increased with increased amount of pineapple pomace powder in dough respectively. Based on the extensograph, enhancement of resistance to extension, and extensibility values though out the 90 min proving time as compared to control sample, suggested that the addition of pineapple pomace powder improves the rheological characteristics and quality of dough. The composite flour needed longer time to evaluate rheological effects on dough as the farinograph requires less time (15 min) to complete than the extensograph (90 min) procedure. Data in this study clearly showed that the rheological properties and the quality of the blended flour dough improved with the addition of pineapple pomace powder.

REFERENCES

Approved methods of the American Association (AACC 2000) of Cereal Chemists (10th ed.) St. Paul: American Association of Cereal Chemists, Inc.

Awoyale, W., Alamu, E.O., Chijioke, U., Tran, T., Takam Tchuente, H.N., Ndjouenkeu, R. and Maziya Dixon, B. 2021. A review of cassava semolina (gari and eba) end user preferences and implications for varietal trait evaluation. *International Journal of Food Science & Technology*. 56 (3): 1206-1222.

Chen, H., Rubenthaler, G.L., Leung, H.K. and Baranowski, J.D. 1988a. Chemical, physical and baking properties of apple fiber compared with wheat and oat bran. *Cereal Chemistry.* 65(3): 244-247.

Desai, A., Brennan, M.A. and Brennan, C.S. 2018. The effect of semolina replacement with protein powder from fish (Pseudophycis bachus) on the physicochemical characteristics of pasta. *LWT*. 89: 52-57.

FAO, 2019. Food and Agriculture Organization Statistics of word production".

Hackenberg, S., Vogel, C., Scherf, K. A., Jekle, M. and Becker, T. 2019. Impact of altered starch functionality on wheat dough microstructure and its elongation behaviour. *Food Chemistry*. 290: 64-71.

Kim, Y., Kim, Y., Bae, I. Y., Lee, H. G. and Lee, S. 2013**.** Preparation of dietary fibre-enriched materials from preharvest dropped apples and their utilization as a high fibre flour substitute. *Journal of the Science of Food and Agriculture.* 93: 1974–1978. DOI: 10.1002/jsfa.6001.

Kohajdová, Z., Karovièová, J. and Šimková, S. 2009. Use of apple fibre in bakery products Acta Fytotechnica *Zootechnica.* 12: 286–291.

Kohajdová, Z., Karovièová, J., Magala, M. and Kuchtová, V. 2014. Effect of apple pomace powder addition on farinographic properties of wheat dough and biscuits quality *Chemical Papers.* 68 (8): 1059-1065.

Kundu, H., Grewal, R. B., Goyal, A., Upadhyay, N. and Prakash, S. 2014. Effect of incorporation of pumpkin (*Cucurbita moshchata*) powder and guar gum on the rheological properties of wheat flour. *Journal of Food Science and Technology*. 51 (10): 2600-2607.

Larrauri, J. A., Rupérez, P. and Calixto, F.S. 1997**.** Pineapple shell as a source of dietary fiber with associated polyphenols. *Journal of Agricultural and Food Chemistry*. 45 (10): 4028-4031.

Martinez, R., Torres, P., Meneses, M.A., Figueroa, J.G. and Perez Alvarez, J.A. 2012. Chemical, technological and in vitro antioxidant properties of mango, guava, pineapple and passion fruit dietary fibre concentrate. *Journal of Food Food Chemistry.* 135: 1520–1526.

Moazzezi, S., Seyedain, S. M. and Nateghi, L. 2012. Rheological properties of barbari bread containing apple pomace and carboxy methyl cellulose. *Life Science Journal*. 9 (3): 1318-1325.

Montalvo-González, E., Aguilar-Hernández, G., Hernández-Cázares, A.S., Ruiz-López, I. I., Pérez-Silva, A., Hernández-Torres, J. and Vivar-Vera, M.D.L.Á. 2018**.** Production, chemical, physical and technological properties of antioxidant dietary fiber from pineapple pomace and effect as ingredient in sausages *CyTA-Journal of Food*. 16 (1): 831-839.

Muñoz, E. and García-Manrique, J.A. 2015. Water absorption behaviour and its effect on the mechanical properties of flax fibre reinforced bioepoxy composites. *International Journal of Polymer Science.*

Sadal, K.B. Dabhade S.B. and Bornare, D.T. 2018. Development and quality evaluation of Pineapple Pomace Powder fortified biscuits *International Journal of Chemical Studies.* 6 (4): 1019-1023.

Selani, M. M., Brazaca, S. G. C., dos Santos Dias, C. T., Ratnayake, W. S., Flores, R. A. and Bianchini, A. 2014**.** Characterization and potential application of pineapple pomace in an extruded product for fibre enhancement. *Journal of Food Chemistry*. 163: 23-30.

Sudha, M. L., Baskaran, V. and Leelavathi, K. 2007**.** Apple pomace as a source of dietary fiber and polyphenols and its effect on the rheological characteristics and cake making. *Food Chemistry.* 104 (2): 686-692

Turksoy, S. and Özkaya, B. 2011. Pumpkin and carrot pomace powders as a source of dietary fiber and their effects on the mixing properties of wheat flour dough and cookie quality. *Food Science and Technology Research.* 17 (6): 545-553.

Upadhyay, A., Lama, J. P. and Tawata, S. 2010. Utilization of pineapple waste: a review. *Journal of Food Science and Technology Nepal*. 6: 10-18.

Usman, M., Ahmed, S., Mehmood, A., Bilal, M., Patil, P. J., Akram, K. and Farooq, U. 2020. Effect of apple pomace on nutrition, rheology of dough and cookies quality. *Journal of Food Science and Technology.* 57 (9): 3244-3251.