ISSN: 0975-833X

*Available online at http://www.journalcra.com*

*International Journal of Current Research*
*Vol. 10, Issue, 06, pp.70848-70856, June, 2018*

**INTERNATIONAL JOURNAL OF CURRENT RESEARCH**

## RESEARCH ARTICLE

# EFFECT OF ADDITION OF WHOLE ROSELLE SEED FLOUR ON RHEOLOGICAL PROPERTIES OF WHOLE WHEAT FLOUR

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**ARTICLE INFO**

***Article History:***
Received 19th March, 2018
Received in revised form
06th April, 2018
Accepted 29th May, 2018
Published online 30th June, 2018

***Key words:***
Amylograph,
Farinograph, Extensograph,
Roselle Seeds Flour.

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**ABSTRACT**

In food processing, rheological properties are critical engineering indices for raw materials pre-considered in food formulations to establish processing requirements suitably adopted for converting raw materials efficiently into finished products. Effects of inclusion of Whole Roselle Seed Flour (WRSF) in composite formulation with Whole Wheat flour in varying percentages 10 to 25 % showed outcomes for Amylograph: gave 60.73 to 63.48 0C for Beginning of gelatinization at 59.58 0C control, 84.53 to 83.65 0C for Gelatinization temperature at 87.08 0C control, 563.25 to 348.00 (AU) for Gelatinization maximum at 838.75 (AU) control. Farinograph: gave 494.00 to 502.50 (BU) for Consistency at 498.75 (BU) control, 83.65 to 78.48 % for Water absorption at 85.18 % control, 83.45 to 78.50 (BU) for Water absorption corrected for 500 BU at 85.08 (BU) control, 78.63 to 73.38 % for Water absorption corrected for 14 % at 79.58 % control, 6.00 to 5.50 min for Development time at 6.78 min control, 2.88 to 1.68 min for Stability at 3.98 min control, 46.00 to 89.50 BU for Mixing Tolerance Index at 31.75 BU control, 8.60 to 7.08 min for Time to break down at 11.68 min control and 85.50 to 70.25 FQN for Farinograph quality number at 116.75 FQN control. Extensograph at 30, 60 and 90 min Proving time; gave 34.00 to 12.50, 29.25 to 13.75 and 22.00 to 12.75 for Energy (cm2) at 38.75, 34.75 and 31.75 (cm2) respectively as control; 273.00 to 97.75, 185.00 to 97.00 and 165.25 to 94.75 for Resistance to Extension (BU) at 304.75, 263.75 and 251.75 BU respectively as control; 87.00 to 81.75, 86.00 to 75.75 and 79.00 to 70.75 for Extensibility (min) at 88.75, 89.75 and 81.75 (min) respectively as control; 275.00 to 120.75, 185.50 to 122.75 and 173.25 to 124.75 for Maximum (BU) at 317.75, 277.75 and 270.75 (BU) respectively as control; 2.93 to 1.28, 1.95 to 1.38 and 1.93 to 1.38 for Ratio Number at 3.58, 3.08 and 3.18 respectively as control; 3.03 to 1.40, 2.03 to 1.58 and 2.03 to 1.33 for Ratio Number (Max) respectively as control. Research findings proved that inclusion of WRSF up to 25 % still holds good functional and great nutritional potentials in value added food products.



**Citation: Karma, Bako Rimamcwe, Chavan, U.D., Ashok Kadlag, Todmal, S.M. and Wani, V.S. 2018.** "Effect of addition of whole roselle seed flour on rheological properties of whole wheat flour", *International Journal of Current Research*, 10, (06), 70848-70856.

## INTRODUCTION

Different food materials and formulations exhibit complex rheological properties with viscosities and viscoelasticity varying depending upon the external conditions applied, such as stress, strain, timescale and temperature. Internal sample variations such as protein concentrations, presence of bioactive compounds and other components are factors that can influence rheological properties. The baking properties of composite flours are based not only on the gluten characteristic but also to a great degree on the extent of gelatinization of the starch present. The porosity and crumb structure of the baked goods also depends upon this factor which also determines the degree of firmness and the shelf life of the product (AACC 2000).

A comparative rheological analysis on the effects of incorporating Roselle seeds flour in composite formulation with wheat can be evaluated using Amylograph, Farinograph and Extensograph determined according to AACC approved methods Number 22-10, 54-21 and 54-10 respectively (AACC, 2000). Amylograph measures the gelatinization temperature ($^0$C), beginning of gelatinization ($^0$C) and gelatinization maximum (AU); Farinograph is used to study the water absorption (corrected for 14%) and dough development time (min), dough stability (min), degree of softening (BU), consistency (BU) and farinograph quality number (FQN). While Extensograph is used to study dough strechability. In Farinograph parameters studied include: Water absorption which indicates the amount of water required to be added to flour for it to be optimally processed into end product, expressed in percentage (%). Arrival time indicates the rate at which water is taken up by the flour expressed in minutes. Departure time indicates when the dough is beginning to break down an indication of dough consistency during processing. Stability time is the difference between arrival and departure time. This indicates the time the dough maintain maximum consistency and is good indication of dough strength expressed in minutes. Mixing Tolerance Index (MTI) is the difference in BU value at the top of the curve at the peak time and the value at the top of the curve 5 minutes after the peak – indicates the degree of softening during dough development. Farinograph provides information regarding flour quality and its possible use in the final baked products. The higher water absorption leads to higher moisture in the final baked crumb. The longer stability means easier handling for the beaker and less possibility of over mixing. Wheat samples are commonly rated worldwide in trade and for final application according to water absorption and stability (AACC, 2000, method 54-21). Based on results of Farinograph evaluation, flours can be generally placed into one of the following description categories as outlined by (Preston, 1984): Weak - Flour with short (less than 2.5 minutes) development times, high MTI value (>100) and low water absorption (less than 55%). Medium - Flours having a dough development time ranging from 2.5 to 4.0 minutes, MTI values in the range of 60 - 100, and absorption of 54% to 60%. Strong - Flours having long development times (4.0 - 8.0 min), low MTI values (15 - 50 BU) and absorptions generally above 58%. Very Strong - Flours having very long development times (>10 min) and very low MTI scores (Less than 10 min).

The farinograph provides information regarding flour quality and its possible use in the final baked products. Optimum Specification of wheat flour for German rolls: Water Absorption (% flour), 58-61; Dough development time (min), 2-6; stability (min), >4; Degree of softening (FU), 80 - 130.Water absorption (% flour) specification of wheat flour for Chinese noodles: for common noodles, 57-59; High quality noodles (general), 58-63; High quality noodles Udon type, 56-60; Cup noodles, 62-63 (AACC, 2000, method 54-21). Amylograph studies flour characteristics which give information on the gelatinization and degradation of the starch contained in the flour as a result of enzyme actions, blending and treatments. The test is evaluated is displayed as: Beginning of gelatinization, Gelatinization temperature and Gelatinization maximum. The program check evaluates if the flour samples meet the quality standard of bread rye (gelatinization temperature ≥ $63^0$C, gelatinization maximum ≥ 200 AU) (AACC, 2000, method 22-10). The Extensograph studies the force which the dough opposes due to stretching. The stretching behavior of the dough influences the baking volume and the gas holding capacity of the dough and consequently the volume of the baked product. The diagram is then evaluated for: Energy, expressed as area covered by the curve. Resistance to extension, expressed as height of the diagram at a length of 5 cm in BU. Extensibility expressed as length of the diagram. Maximum, expressed as the Highest point of the curve in (BU). Ratio number, expressed as the Quotient of resistance to extension and extensibility, and Ratio number (max), expressed as the Quotient of maximum and extensibility. Each kind of baked product requires specific dough properties which may not be required or may even be undesirable for another baked product. For bread; a strong dough with a good extensibility, good resistance, high energy (large area), and a well-balanced height-to-length ratio is needed. For hard biscuits or crackers; the dough should be extensible and flowing, with a high extensibility and a low resistance. (Adopted from method 54-10, Approved methods of the American Association of Cereal Chemists $10^{th}$ ED, 2000 The Association, St.Paul, MN).

## MATERIALS AND METHODS

**Materials:** Roselle (*Hibiscus sabdariffa L.*) and Wheat (*Triticum aestivum spp.*) seeds were sourced from the vegetable market in Ahmednagar, Maharashtra State, India and both were of local varieties.

**Cleaning:** The seeds were cleaned by washing to separate poor quality seeds, adhering dust particles, stones, plant debris and dried carefully at ambient conditions under fan to preserve its nutritive value, packed in a HDPE bag and stored in a cool dry place until used.

**Equipments:** Laboratory scale hammer mill was used in milling the seed samples is available in the Department of Food Science and Technology, Post Graduate Institute Mahatma Phule Agricultural University, Rahuri Ahmednagar District Maharashtra State, India.

**Treatments:** The flour composite formulations were prepared accordingly at 10-90 %, 15-85 %, 20-80 % and 25-75% inclusion of Whole Roselle Seed Flour (WRSF) with Whole Wheat flour 100 % as Control, then packed separately in a HDPE bag and stored in a cool dry place until used.

**Methods**

Globally the current Brabender Amylograph -E, Farinograph -E and Extensograph -E standard method (AACC, 2000) methods: 22-10, 54-21 and 54-10 respectively were employed to study the rheological properties and characteristics of the composite flours to ascertain the effect of incorporating WRSF with Whole Wheat Flour.

**Statistical Analysis:** Five treatments were used for this test with each value as an average of four determinations so that the degree of freedom is not less than 12. Data obtained in the present study were analyzed by Completely Randomized Design (C.R.D.) design as given by Panse and Sukhatme (1967).

## RESULTS AND DISCUSSION

**Rheological Studies:** An in-depth literature search revealed that the rheological effects of incorporating Roselle seed flour in a composite dough formulation with wheat flour have not yet been studied. Thus this study was conducted to investigate the rheological behaviour of the composite flour to ascertain the baking properties and potentials of the flour mixtures. The results for the *Amylograph*, *Farinograph* and *Extensograph studied* are outlined below:

**Amylograph Studies:** The gelatinization and pasting characteristics of the composite flours (Roselle seed flour and wheat flour) were studied. The results outlined showed that the baking properties of flour are based not only on the gluten characteristics but also to a great degree on the extent of gelatinization of the starch. The porosity and the crumb structure of the baked goods depend upon this factor which also determines the degree of firmness and the shelf life of the product (AACC, 2000) standard method. The results of amylograph of composite flour (Un-sprouted Whole Roselle seed flour and wheat flour) are presented in Table 1 and in Figure 1 to 5 for the characteristics: beginning of gelatinization, gelatinization temperature and gelatinization maximum.

Results of amylograph studies showed effects of inclusion of Un-sprouted Whole Roselle Seed Flour (UWRSF) in composite formulation with Whole Wheat flour in varying percentages 10 to 25 % gave 60.73 to 63.48 $^{0}$C for Beginning of gelatinization at 59.58 $^{0}$C control, 84.53 to 83.65 $^{0}$C for Gelatinization temperature at 87.08 $^{0}$C control, 563.25 to 348.00 (AU) for Gelatinization maximum at 838.75 (AU) control.

**Table 1. Effects of addition of whole Roselle seeds flour (WRSF) on Amylograph characteristic of dough**

| Treatments (%) | Beginning of gelatinization ($^{0}$C) | Gelatinization temperature ($^{0}$C) | Gelatinization maximum (AU) |
|---|---|---|---|
| Control 00:100 | 59.58 | 87.08 | 838.75 |
| WRSF 10:90 | 60.73 | 84.53 | 563.25 |
| WRSF 15:85 | 61.88 | 84.48 | 467.75 |
| WRSF 20:80 | 62.33 | 83.95 | 413.50 |
| WRSF 25:75 | 63.48 | 83.65 | 348.00 |
| SE(±) | 0.04 | 0.05 | 0.47 |
| CD at5 (%) | 0.14 | 0.15 | 1.42 |
| CV (%) | 0.16 | 0.12 | 0.18 |

Each value is an average of four determinations. NB: Treatments details as – WRSF (Whole Roselle Seed Flour). Roselle seed flour: Wheat Flour (00.100; 10:90; 15:85; 20:80; 25:75).

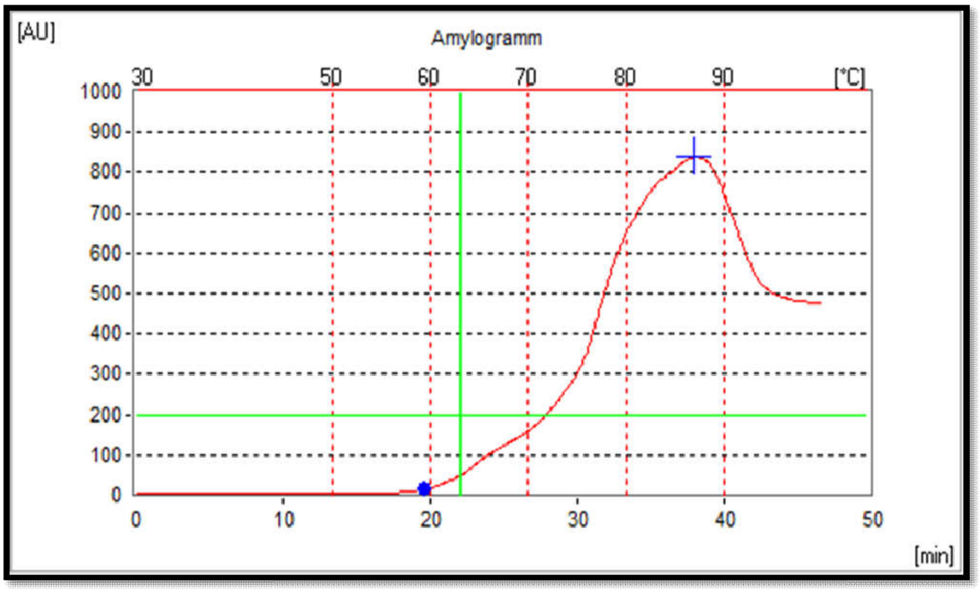


**Figure 1. Amylogram of dough prepared with 100% Wheat flour (Control)**

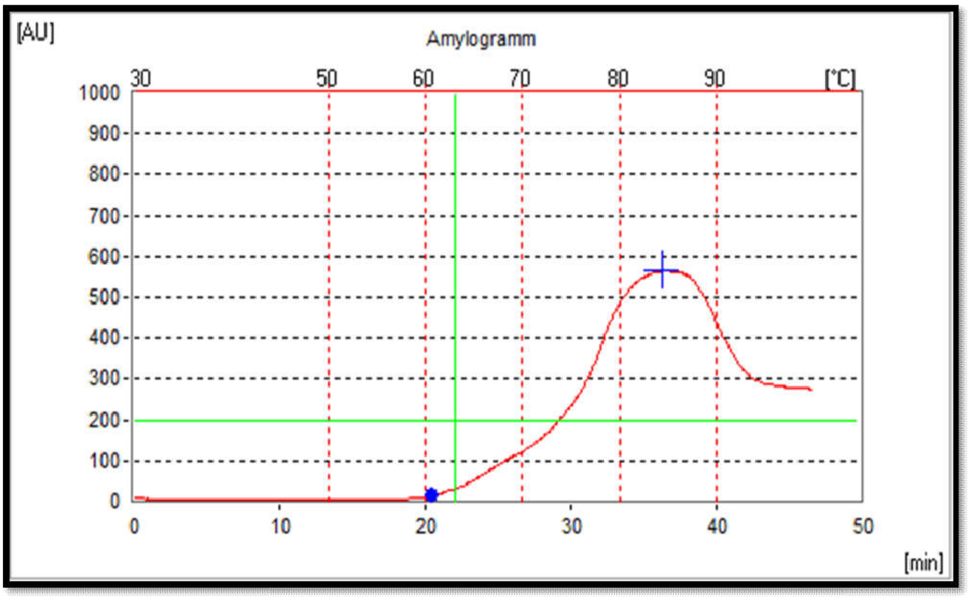


**Figure 2. Amylogram of dough prepared with WRSF 10-90% composite flour**

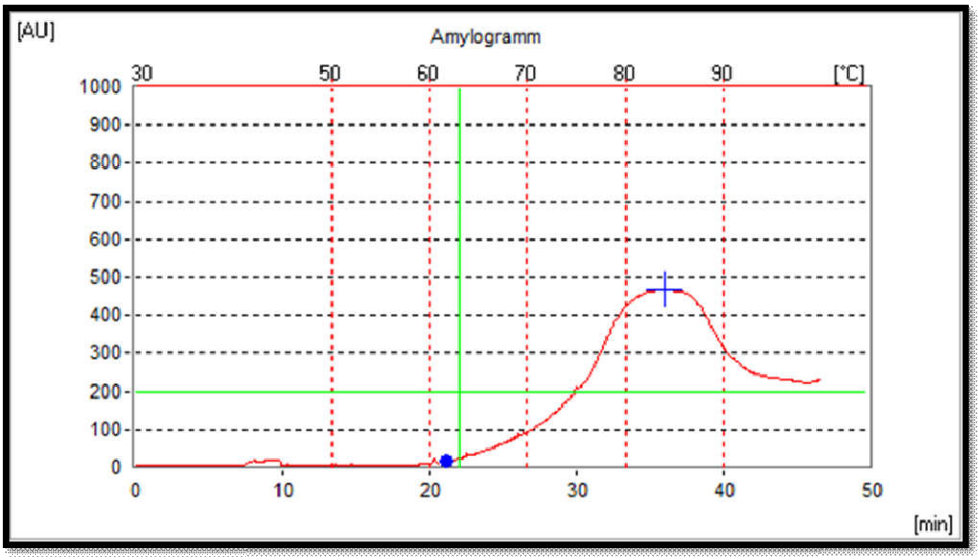


**Figure 3. Amylogram of dough prepared with WRSF 15-85% composite flour**

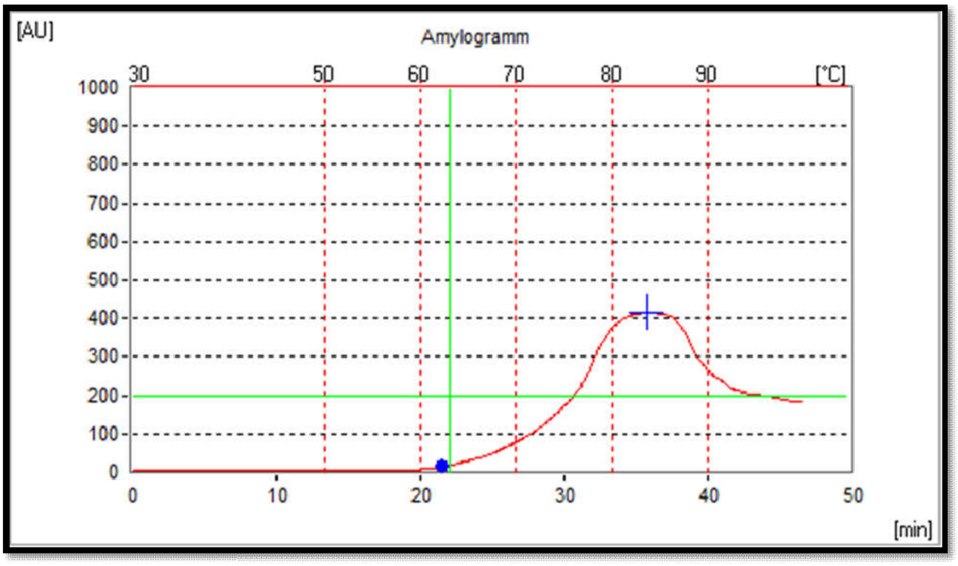


**Figure 4. Amylogram of dough prepared with WRSF 20-80% composite flour**

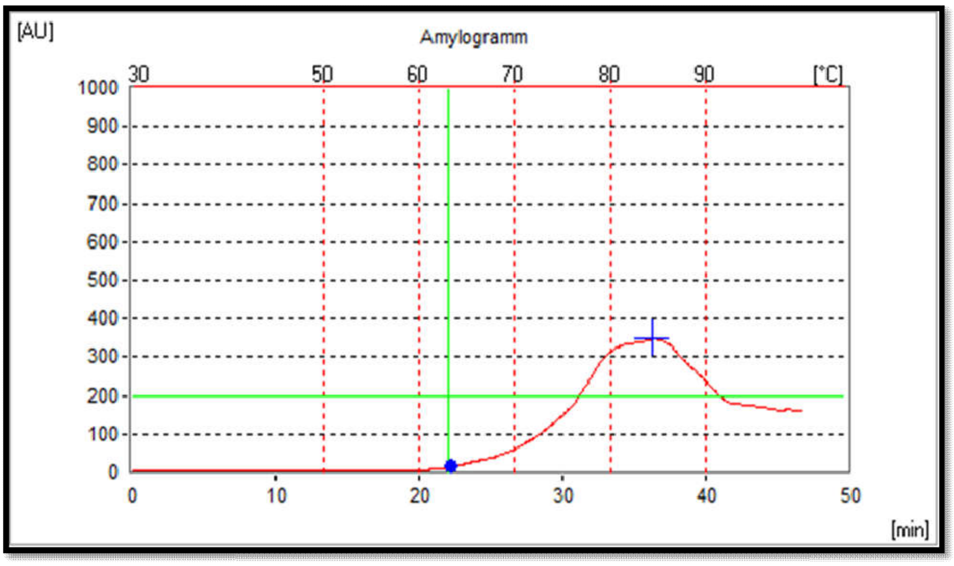


**Figure 5. Amylogram of dough prepared with WRSF 25-75% composite flour**

The results showed that the higher percentage of WRSF inclusion in the composite mix increased the temperature required to begin gelatinization of the composite slurry in all the treatments, with a corresponding decrease in gelatinization temperature showing an inverse relationship Table 1. The difference in gelatinization temperatures between each of the treatment were considered significant at $P<0.05$; but 10 % and 15% substitution were at par with control. The difference in beginning of gelatinization and gelatinization temperature of the slurry decreases with inclusion of WRSF which reflects the degree and the extent of gelatinization. 10% WRSF inclusion showed a higher deviation followed by 15% and 25 % having the least value. There was a significant difference in the temperature ($P>0.05$) between each treatments.

However, in all the treatments the amylogram reveals that the samples meets the standard quality of bread rye, because all the gelatinization temperature was above 63$^{o}$C and the gelatinization maximum was above 200 AU (AACC, 2000 Standard Method No. 22-10). The effect of increase in addition of Whole Roselle Seed Flour (WRSF) in the composite mix showed a direct linear relationship with beginning of gelatinization (BG) in ($^{o}$C) with inverse relationship with gelatinization temperature (GT) in ($^{o}$C) and gelatinization maximum (GM) in (AU); expressed mathematically as:

$$A \propto \left[\frac{BG}{GT \times GM}\right]$$

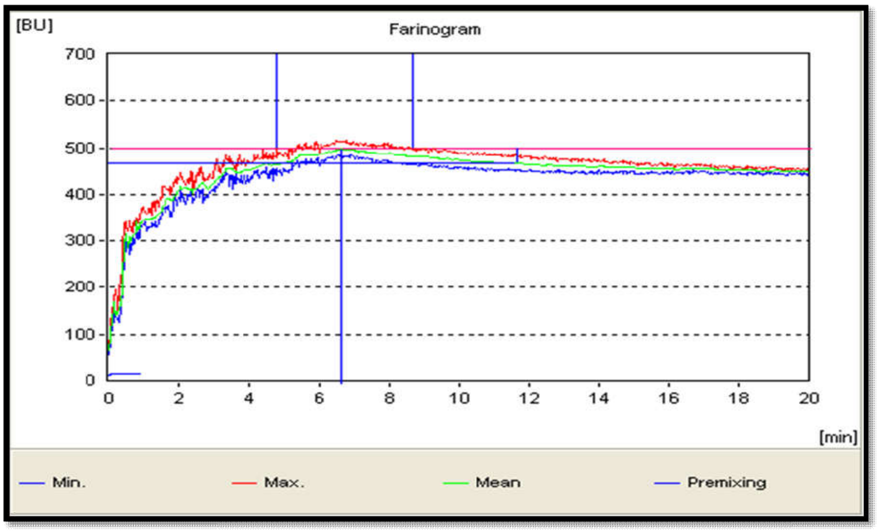


**Figure 6. Farinogram of dough prepared with 100% Wheat flour (Control)**

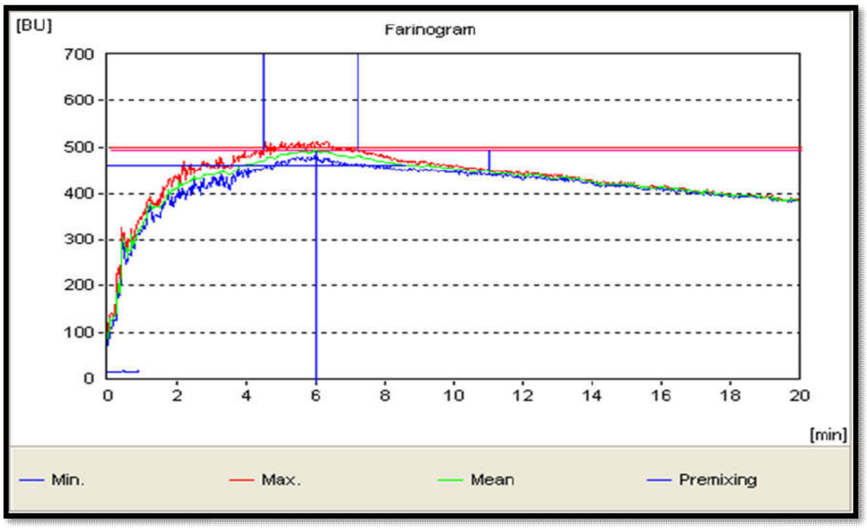


**Figure 7. Farinogram of dough prepared with WRSF 10-90 % Composite flour**

This could be as a result of reduction in overall starch (Nyam, 2014; Karma and Chavan, 2016) and gluten contents of the composite flour which is responsible for the gelling and viscoelastic properties to the flour (Bengoechea *et al*., 2006; Karma and Chavan, 2016). Roselle seed has high protein content and as such inclusions in the composite mix will only enrich the nutrient value of the flour (Karma and Chavan, 2016); justifying the decrease in gluten and starch content of the composite mix. Gelatinization Maximum (BU) also decreased in all treatments with the inclusion of WRSF; with 25 % inclusion having the least values.

Where A stands for increase in addition of Whole Roselle Seed Flour (WRSF) a direct effect of increase in protein, lipid profile (Nzikou *et al.,* 2011; Ismail *et al.*, 2008; Karma and Chavan, 2016) and decrease in gluten contents (Karma and Chavan, 2016); suggesting that incorporating flour of protein source of high biological value, lipid content and reduced gluten value in a composite flour slurry will result in a direct increase in Beginning of Gelatinization ($^{0}$C) and reduction in Gelatinization Temperature ($^{0}$C) and Gelatinization Maximum (AU) for amylograph studies.

**Farinograph-E Studies:** For decades the Farinograph-E has been the standard instrument for measuring the water absorption, development time, stability, mixing tolerance index (MTI), time to break down and the farinograph quality number of the flour and whole meal, as well as testing the mixing and processing behavior of dough. These values extracted from the farinograph study can be used as a relative composite description of flour's overall quality characteristics. This has been used worldwide in accordance to international standard (AACC, 2000 Method No. 54-21). Farinograph results for composite flour of WRSF and Whole Wheat Flour treatments are shown in Table 2 and represented graphically in Figures 6 to 10. Having MTI values of 46.00, 52.50 and 31.75 BU; development time 6.00, 5.90 and 6.78 min; and water absorption 78.63, 76.60 and 79.58 % respectively (Table 2); there was a significant difference (P<0.05) between the observed values of dough characteristic of all the treatment formulations. Water absorption, development time, stability, and farinograph quality number (FQN) values decreased with inclusion of WRSF in the composite mix, with the exception of MTI (BU) showing an inverse relationship. For Un-sprouted whole Roselle seeds flour (UWRSF) addition, farinograph characteristics of dough showed inclusion up to 15% as optimum (Table 2.0); meeting German rolls and Chinese noodles specifications. (AACC, 2000)

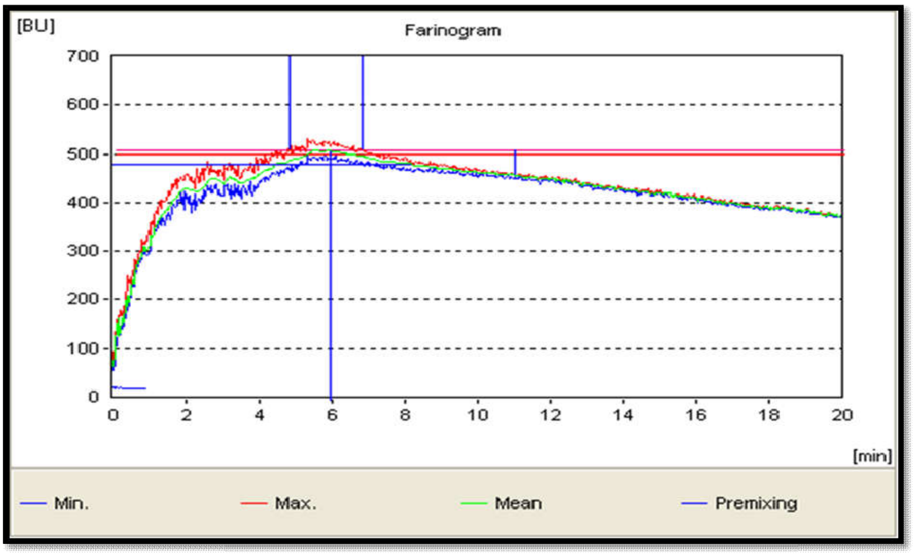


**Figure 8. Farinogram of dough prepared with WRSF 15-85 % Composite flour**

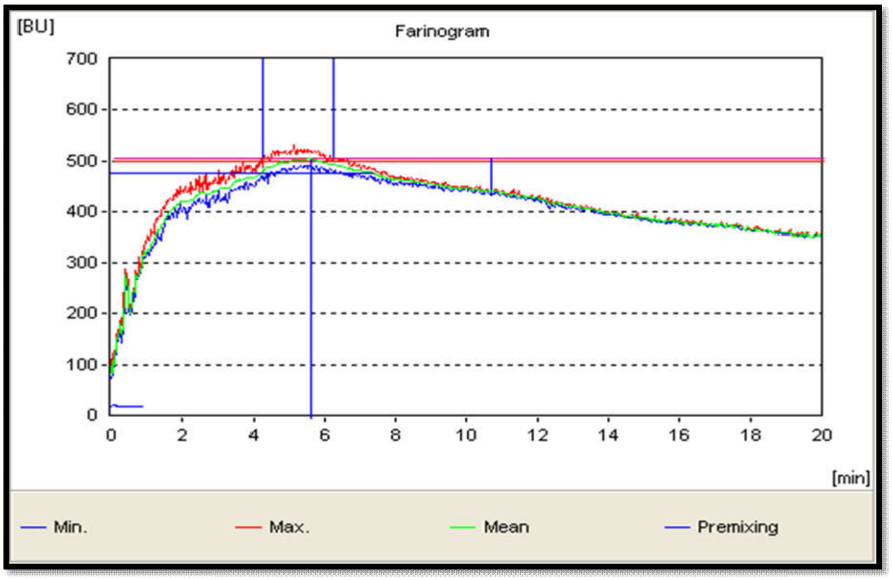


**Figure 9. Farinogram of dough prepared with WRSF 20-80% Composite flour**

Based on the descriptive categories outlined by Preston (1984), the results obtained from farinograph studies outlined in Tables 4.13 to 4.16 of the composite flour formulations can be categorized as follows:

For whole Roselle seed flour (WRSF); the range 10% to 15% and 20% to 25% composite flours can be categorized as strong and medium flours respectively (Preston, 1984), with 10% and 15% compared favourably with the control as strong flours.

This study provides sufficient results on water absorption and dough development properties of Roselle seeds flour in composite formulation with wheat; results may serve as a guide to bakers in the utilization of WRSF as an enriched ingredient in value added bakery products. Whole seed flour treatments are more fiber rich (El-Adawy and Khalil, 1994; Ismail *et al.,* 2008) as such that could improve significantly the flour functional properties.

**Table 2. Effects of addition of whole Roselle seeds flour (WRSF) on farinograph characteristics of dough**

| Treatments (%) | Consistency (BU) | Water absorption % | Water absorption (corrected for 500 BU) | Water absorption (corrected for 14 %) | Dev. time (min) | Stability (min) | Mixing Tolerance Index (BU) | Time of break down (min) | Farinograph quality number (FQN) |
|---|---|---|---|---|---|---|---|---|---|
| CONTROL, 00.100 | 498.75 | 85.18 | 85.08 | 79.58 | 6.78 | 3.98 | 31.75 | 11.68 | 116.75 |
| UWRSF, 10-90 | 494.00 | 83.65 | 83.45 | 78.63 | 6.00 | 2.88 | 46.00 | 8.60 | 85.50 |
| UWRSF, 15-85 | 505.50 | 81.03 | 81.20 | 76.60 | 5.90 | 2.33 | 52.50 | 8.28 | 82.75 |
| UWRSF, 20-80 | 503.25 | 79.55 | 79.63 | 74.55 | 5.65 | 1.95 | 63.95 | 7.35 | 74.00 |
| UWRSF, 25-75 | 502.50 | 78.48 | 78.50 | 73.38 | 5.50 | 1.68 | 89.50 | 7.08 | 70.25 |
| SE(±) | 0.96 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.34 | 0.04 | 0.39 |
| CD at 5 (%) | 2.90 | 0.11 | 0.13 | 0.13 | 0.12 | 0.12 | 1.01 | 0.13 | 1.18 |
| CV (%) | 0.38 | 0.09 | 0.10 | 0.11 | 1.35 | 3.19 | 1.18 | 1.01 | 0.91 |

Each value is an average of four determinations. NB: Treatments details as – WRSF (Whole Roselle Seed Flour) Roselle seed flour: Wheat Flour (00:100; 10:90; 15:85; 20:80; 25:75).

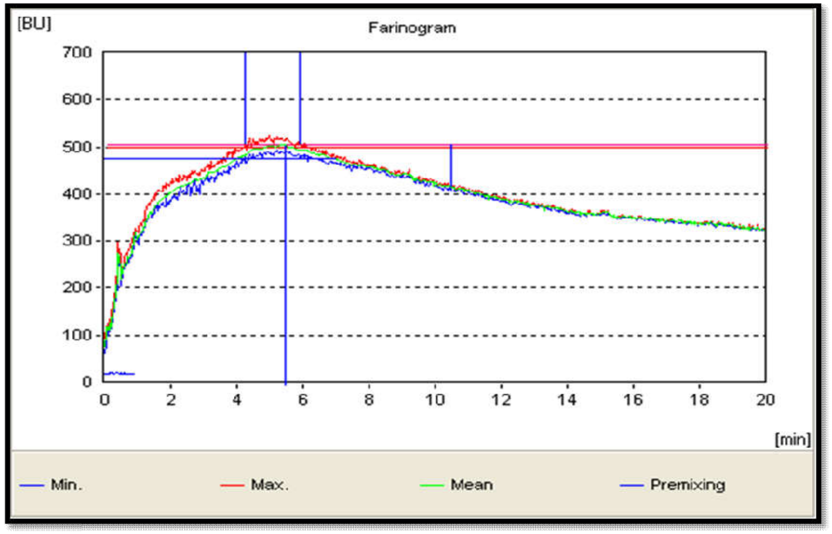


**Figure 10. Farinogram of dough prepared with WRSF 25-75 % Composite flour**

**Table 3. Effects of addition of whole Roselle seeds flour (WRSF) on Energy (cm$^2$)**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 38.75 | 34.75 | 31.75 |
| UWRSF 10-90 | 34.00 | 29.25 | 22.00 |
| UWRSF 15-85 | 26.75 | 24.75 | 20.75 |
| UWRSF 20-80 | 15.50 | 15.25 | 16.25 |
| UWRSF 25-75 | 12.50 | 13.75 | 12.75 |
| SE(±) | 0.57 | 0.48 | 0.56 |
| CD at5 (%) | 1.72 | 1.44 | 1.70 |
| CV (%) | 4.47 | 4.07 | 5.43 |

Each value is an average of four determinations.

**Extensograph Studies:** The Extensograph technique was used to study the rheological properties of the composite flour treatments. Under this study energy required, resistance to extension, extensibility, maximum (BU), ratio number and ratio number (Max) index parameters were studied. For Whole Wheat Flour (control), Whole Roselle seed flour (Table 3 to 8 and Figure 11 to 15).

### Un-Sprouted Whole Roselle Seed Flour

**Table 4. Effects of addition of whole Roselle seeds flour (WRSF) on Resistance to Extension (BU)**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 304.75 | 263.75 | 251.75 |
| UWRSF 10-90 | 273.00 | 185.00 | 165.25 |
| UWRSF 15-85 | 199.00 | 174.75 | 162.50 |
| UWRSF 20-80 | 120.75 | 120.25 | 129.25 |
| UWRSF 25-75 | 97.75 | 97.00 | 94.75 |
| SE(±) | 0.64 | 0.45 | 0.48 |
| CD at5 (%) | 1.92 | 1.36 | 1.40 |
| CV (%) | 0.64 | 0.54 | 0.60 |

Each value is an average of four determinations.

**Table 5. Effects of addition of whole Roselle seeds flour (WRSF) on Extensibility (mm)**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 88.75 | 89.75 | 81.75 |
| UWRSF 10-90 | 87.00 | 86.00 | 79.00 |
| UWRSF 15-85 | 85.75 | 84.75 | 77.75 |
| UWRSF 20-80 | 82.50 | 77.00 | 75.75 |
| UWRSF 25-75 | 81.75 | 75.75 | 70.75 |
| SE(±) | 0.50 | 0.45 | 0.56 |
| CD at5 (%) | 1.52 | 1.36 | 1.70 |
| CV (%) | 1.18 | 1.09 | 1.46 |

Each value is an average of four determinations

**Table 6. Effects of addition of whole Roselle seeds flour (WRSF) on Maximum (BU)**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 317.75 | 277.75 | 270.75 |
| UWRSF 10-90 | 275.00 | 185.50 | 173.25 |
| UWRSF 15-85 | 211.75 | 181.75 | 168.00 |
| UWRSF 20-80 | 133.25 | 149.75 | 151.25 |
| UWRSF 25-75 | 120.75 | 122.75 | 124.75 |
| SE(±) | 0.47 | 0.52 | 0.53 |
| CD at5 (%) | 1.40 | 1.56 | 1.60 |
| CV (%) | 0.44 | 0.56 | 0.60 |

Each value is an average of four determinations.

**Table 7. Effects of addition of whole Roselle Seeds flour (WRSF) on Ratio Number**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 3.58 | 3.08 | 3.18 |
| UWRSF 10-90 | 2.93 | 1.95 | 1.93 |
| UWRSF 15-85 | 2.38 | 1.88 | 1.88 |
| UWRSF 20-80 | 1.33 | 1.53 | 1.53 |
| UWRSF 25-75 | 1.28 | 1.38 | 1.38 |
| SE(±) | 0.04 | 0.05 | 0.04 |
| CD at5 (%) | 0.14 | 0.15 | 0.14 |
| CV (%) | 4.17 | 5.27 | 4.85 |

Each value is an average of four determinations.

**Table 8. Effects of addition of whole Roselle seeds flour (WRSF) on Ratio Number (Max.)**

| Treatments (%) | Proving Time (min) | | |
|---|---|---|---|
| | 30 | 60 | 90 |
| Control 00.100 | 3.68 | 3.18 | 3.38 |
| UWRSF 10-90 | 3.03 | 2.03 | 2.03 |
| UWRSF 15-85 | 2.58 | 1.80 | 1.78 |
| UWRSF 20-80 | 1.53 | 1.63 | 1.53 |
| UWRSF 25-75 | 1.40 | 1.58 | 1.33 |
| SE(±) | 0.05 | 0.06 | 0.06 |
| CD at5 (%) | 0.14 | 0.17 | 0.19 |
| CV (%) | 3.82 | 5.52 | 6.28 |

Each value is an average of four determinations.

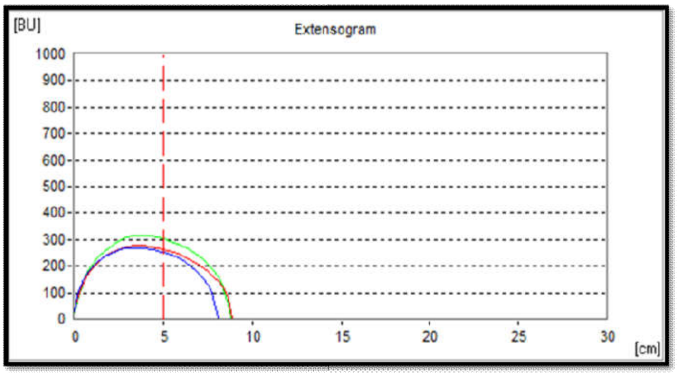


**Figure 11. Extensogram of dough prepared with 100 % wheat flour (Control)**

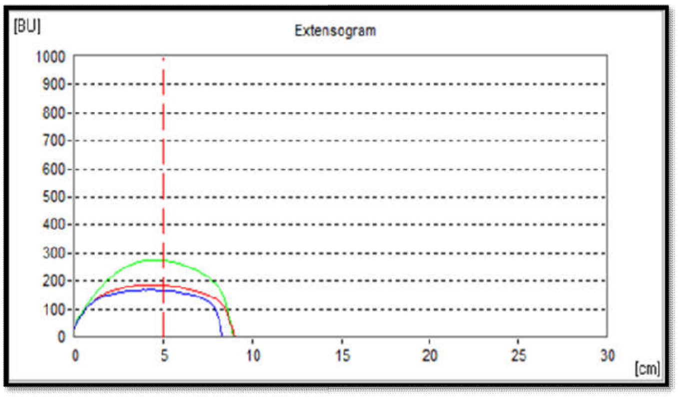


**Figure 12. Extensogram of dough prepared with WRSF 10-90 % composite Flour**

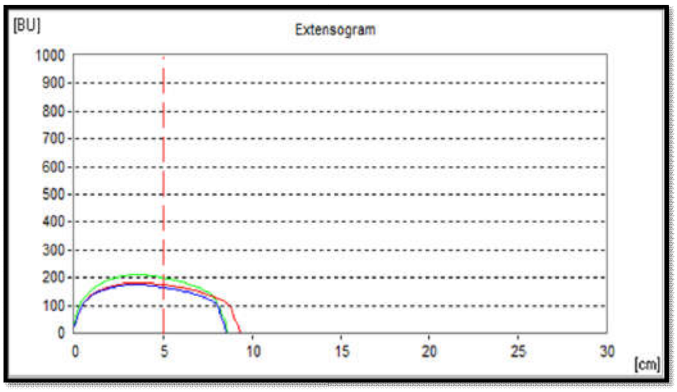


**Figure 13. Extensogram of dough prepared with WRSF 15-85 % composite Flour**

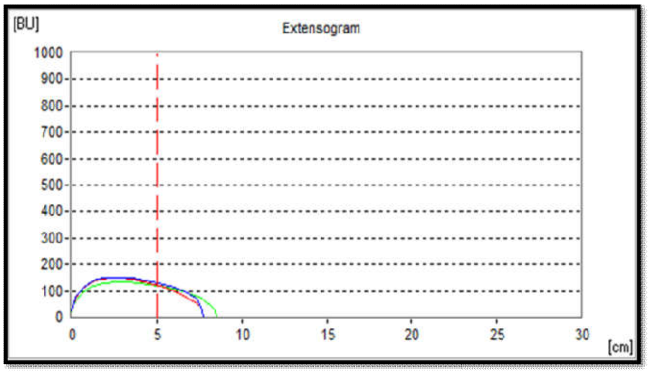


**Figure 14. Extensogram of dough prepared with WRSF 20-80 % composite Flour**

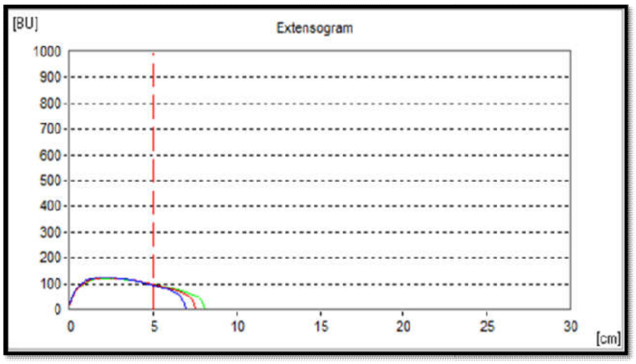


**Figure 15. Extensogram of dough prepared with WRSF 25-75 % composite Flour**

The results of Extensograph studies revealed that increase addition of Whole Roselle Seed Flour (WRSF) in the formulations generally resulted to decrease in Energy ($cm^2$), Resistance to Extension (BU), Extensibility (mm), Maximum (BU), Ratio Number and Ratio Number (Max) with significant difference $P<0.05$ in all the treatments. The extensograph is a test that measures the stretching behavior of the dough as influenced by grain quality and flour treatment with additives. And because Whole seed flour treatments are more fiber rich (El-Adawy and Khalil, 1994; Ismail *et al.,* 2008) as such, that could affect significantly the stretching properties of the dough formulations, as a result of reduce gluten and overall starch contents (Bengoechea *et al*., 2006; Karma and Chavan, 2016). There are no literatures on these aspects for supporting these results.

## Conclusion

Roselle Seeds Flour holds good potentials in terms of its nutritional and functional properties. Roselle seeds can offer huge food benefits if incorporated in value added cereal food products as a very economical crop owing to its ease of cultivation and yield especially in the tropics.

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