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Effect of shallot waste (*Allium cepa* L. var. *aggregatum*) and their extracts on quality of developed pasta

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Abstract
Onion is one of the major food commodity that is cultivated and consumed throughout the world. Shallot onion is a variety that is distinctly known for the pungency and the flavor. The production and processing of shallot produces various waste streams which causes environmental issues due to mere dumping as waste. So, the study is undertaken to investigate the possibilities of utilizing these waste streams in the food system either by direct substitution (Peel powder-PP and Stalk powder-SP) or by addition of extract (Peel extract-PE and Stalk extract-SE) at 10 and 20% in pasta. Results revealed that substitution of refined wheat flour with shallot waste powder significantly reduces the carbohydrate content and lowest was observed in SP-20 (73.78±0.09%) and highest value of 78.95±0.07% was observed in control sample. The similar trendsa were observed in energy value of developed pasta. Shallot waste streams are rich in fiber content, and substitution of these waste streams powder increases the fiber content significantly. Physical properties such as hardness showed significant decrease on shallot waste substitution which reduces from 8432.71±41.95 g force in controlled sample to 6884.66±68.16, 6870.98±134.73, 5736.93±147.1 and 6794.05±33.8 in PP-20, SP-20, PE-20 and SE-20, respectively. Major highlight observed was increase in antioxidant activity on addition of shallot waste extract to 13.39±0.14 and 9.63±0.10 in PE-20 and SE-20 samples respectively. The change in antioxidant activity is mainly due to presence of 50.43 and 19.19 ppm of quercetin in shallot peel and stalk. In a nutshell, substitution or addition of shallot waste powder or extract improves the nutritional quality of pasta and subsequently reducing the environmental pollution and have great potential in food systems.

Keywords: Shallot waste, value addition, pasta, nutritional composition, anti-oxidant activity, quercetin

1. Introduction

Onion is highly grown and utilized commodity worldwide accounting for 93 million metric ton of annual production. The major producer of onion is China followed by India, Egypt, United State of America and Iran. India is the second largest producer of onion in the world which produces around 19 million metric ton of annual production over the land of 1.2-million-hectare land. However, the productivity in India is lower compared to other major producing countries accounting 16,181.5 kg/hectare [1]. There are many varieties grown worldwide. Among these shallot onion *Allium cepa* L. var. *aggregatum* is one known for its distinguished flavor and pungency. Shallot onion have great demand in various south Asian countries. The lower productivity makes it important to utilize all the produce effectively. But, the perishable nature of onion makes it difficult for longer storage distant transportation. This opens up the opportunities for the processing of onion which convert the surplus amount into value added products such as paste, dried onion flakes, powder, pickles etc. Currently the studies have been undertaken for freezing and cold storage preservation of minimally processed onion. This enables the longer storage and export to various places around the globe.

The production and processing of shallot for value added product also produces various wastes *viz*. flower and petiole during harvesting and peel and stalk during processing. Conventionally these wastes were either thrown in landfills or used as animal feed in very minute quantity causing several environmental hazards. Moreover, these wastes were not emphasized for their utilization through dedicated research. However, the big onion peel only given the importance for waste utilization and found that it is a good source of insoluble and soluble fibers [2], various minerals [3]. Onion peel is a good source of total phenols, total flavonoids and possesses anti-oxidant activity [4] which is thrice as that of fresh onion and highly contributed by Quercetin [5]. Due to this composition, peel is used as source of quercetin [6], polysaccharide and sugar [7], packaging ingredient [8], absorbent [9] and substrate for vinegar production [10].

So, current study is aimed towards the substitution of refined wheat flour with shallot waste powder and also added with the extract of these wastes and analyze the quality of the developed pasta. The hypothesis was considered that degree of substitution would help the value addition of developed pasta in terms of nutritional benefits which enables the returns to the producers and processors.

2. Material and Methods

2.1 Sample collection

The waste streams (peel, stalk, flower, and petiole) from cured shallot onion of CO-2 variety were collected from a local industry at Perambalur district of Tamil Nadu, India. The collected samples were cleaned manually to remove the dockages and adhered materials. Ingredients used for pasta preparation were purchased from the local market in Thanjavur. The chemicals used were procured from Hi-Media Laboratories Pvt. Ltd. (Himedia, Nashik, India) and were of analytical grade.

2.2 Sample preparation

2.2.1 Preparation of shallot waste powder

The collected shallot waste streams were dried overnight using a tray dryer and the temperature was maintained at 50°C. The sample was the ground at room temperature using pin mill to get the fine powder. The ground powder was then sieved through a 210-micron sieve to get the uniform size powder which matches with refined wheat flour. Further these shallot waste powders were mixed with refined wheat flour as given in table 1 and used for further experiment.

2.2.2 Preparation of shallot waste extract

The anti-oxidant activity of shallot waste is majorly contributed by quercetin. Quercetin is a plant flavonoid which mainly found in onion. It is water soluble compound that can be extracted by water treatment of shallot waste. To serve the purpose, the shallot wastes were collected and dried in RF drier to reduce moisture as well as microbial load on it. Further these waste streams were ground. The powdered shallot wastes were then applied with hydrothermal treatment with solid: liquid ratio of 1:10 and heated at 60°C for 1 h. The liquid is then cooled immediately and filtered through whatmann filter paper no 1 and stored at refrigerated condition until further use.

2.3 Preparation of pasta

Pasta is one of the major part of western diet. However, the pasta is made of refined wheat flour having very less antioxidant activities. So, to solve the issue the aqueous anti-oxidant extract obtained from shallot waste was added to refined wheat flour 10% and 20% concentration as given in table 1. The cold extrusion was applied in order to avoid thermal degradation of shallot antioxidants due to very high thermal exposure in hot extrusion. The developed pasta is steamed to allow the starch to gelatinize giving the desired strength to it and then dried at 50 °C for 12 hours and stored at room temperature till further use.

Table 1: Mixing proportion of RWF and selected shallot waste powder and extract

Constituents	Concentration	
RWF (g)	90	80
Peel powder (g)	10	20
Stalk powder (g)	10	20
RWF (g)	100	100
Peel extract (ml)	10	20
Stalk extract (ml)	10	20

RWF-Refined wheat flour

2.4 Quality evaluation of pasta

2.4.1 Composition analysis

The developed pasta was initially analyzed for the proximate composition. The pasta was analyzed for moisture, protein, fat, fibers and ash using standard AOAC methods [11]. Further the amount of carbohydrates were calculated by the difference method given by Theagarajan *et al*. (2019) [12].

2.4.2 Energy calculation

The amount of energy a food product can give decides its consumption pattern. So, by considering this, the energy value for developed pasta were calculated by multiplying the composition with respective factors to obtain its energy [12].

2.4.3 Antioxidant activity

Developed pasta were ground to get coarse powder and this powder was further added in methanol in ratio 1:10 and kept on rotary shaker for period of 12 h to extract the active components from it. Then the mixture is filtered through whatmann filter paper no 1 and the extract was obtained. The obtained extract was then further analyzed for antioxidant activity using DPPH scavenging activity and the results are calculated with equation 1 and presented as percentage of scavenging activity [13].

$$DPPH\ Scavenging\ Activity\ (\%) = \frac{Absorbance_c - Absorbance_s}{Absorbance_c} \times 100 \ldots I$$

2.4.4 Color analysis

Color plays an important role in acceptance of the product, hence the color of developed pasta was measured using a Hunter color lab model D25 optical sensor (Hunter Associates Laboratory, Reston, VA). The color of pasta was accessed in terms of L*, a* and b* values. In this coordinate system, the L* value represents lightness, ranging from 0 (black) to +100 (white); the a* value ranges from −50 (greenness) to +50 (redness), and the b* value ranges from −50 (blueness) to +50 (yellowness) [13].

2.4.5 Texture analysis

The hardness of developed pasta was analyzed for texture using texture analyzer (TA-HD plus TPA). The program was modified for compression mode. Five kg load cell was mounted on the equipment which triggers the measurement after touching the pasta sample. The pasta sample was on heavy duty platform (HDP/90) so that it remains in most stable position. The test was performed with 2 mm cylindrical probe (P/2) with pre-test speed of 1.5 mm/sec, test speed 1.0 mm/sec and after the data acquisition, post-test speed of 10 mm/sec. The hardness was considered at the highest point on the plot at which the pasta sample breaks [14].

2.4.6 Quercetin analysis

Quercetin is the major antioxidant present in shallot waste, hence to justify the antioxidant activity of the shallot waste the amount of quercetin was measured using HPLC analysis [15]. The shallot waste samples of peel and stalk were extracted for aqueous extract as given in section 2.2.2 and the extract was then further analyzed for quercetin content.

2.4.7 Statistical analysis

The analysis of all the parameters was performed and represented as mean±sd in various forms further in manuscript. The obtained data was analyzed for statistical significance (p=0.05) using a computer application of MINI TAB 17.

3. Results and Discussions

3.1 Compositional analysis

The composition of the developed pasta samples was analyzed in terms of proximate composition with methodology as described earlier and the results are represented in figure 1 and discussed as follow.

3.1.1 Moisture

The amount of free water present in the food is known as moisture content of that commodity. The pasta developed with substitution of shallot waste and adding aqueous extract from the shallot were analyzed for the moisture. The results revealed that the control sample was observed with 8.10±0.17% moisture which further decreases with direct substitution of shallot waste powder and lowest moisture was observed in the sample substituted with 20% of shallot stalk powder. The addition of shallot waste extract does not show any significant difference in the moisture content when compared with controlled sample. The fibers present in shallot waste powder absorb more water and hence need more water for the blending the dough to the similar consistency as controlled sample which makes most of the water unavailable and hence lower moisture in it. Whereas, when added with shallot waste extract, the higher polyphenols in the extract make simple hydrogen bonding with the water molecules and hence retain higher free water in it [8].

3.1.2 Protein

Shallot waste *viz*. peel and stalk both are deficient in protein [15] and hence direct substitution of these waste streams powder into pasta with refined wheat flour decreases the amount of protein content from 11.22±0.055% in controlled sample to 10.2±0.05 and 10.35±0.051 in PP 20 and SP 20 respectively. Though this change in the protein content is minor but showed significant change at p=0.05. Considering other pasta samples, the protein content reduces, but the reduction of it does not show any significance. The protein in the refined wheat flour is mainly due to gluten which is responsible for the elasticity of the dough and structure of the wheat product. The reduction in protein content may lead towards the fragile product with lower textural integrity. The similar results were observed by Bustos *et al*. when four different fiber were substituted in pasta [16].

3.1.3 Fat

The fat content of the wheat grain is mainly concentrated in germ portion. While processing of refined wheat flour, the germ portion is removed and hence it contains very less amount of fat in it [17]. This could be the reason for lower fat content of 0.25±0.002% in controlled sample. The samples added with shallot waste extract showed similar amount of fat in it even at higher addition of aqueous extracts (PE-20% - 0.25±0.002 and SE-20% - 0.26±0.002). The highest amount of fat content was found in SP-20% accounting for 0.35±0.005. This may be due to the compounds which are soluble in organic solvents and higher fat content in the shallot stalk. The sample added with shallot waste powder were found significantly different with control and reverse was observed in sample with shallot waste extracts.

3.1.4 Fiber

The results revealed that addition of shallot waste powder for development of pasta increases the fiber content compared to 0.85±0.003 in controlled sample. The fiber content increases with degree of substitution. Highest amount of fiber increase was observed in samples added with shallot peel powder which increases to 4.52±0.013% in PP-20% from 2.86±0.01 in PP-10%. The shallot waste were reported to contain higher fiber content in it and the highest was observed in peel and the observed results coincide with the findings of this study [15].

3.1.5 Ash

Ash content present in food commodity represents the amount of minerals present in it. The shallot waste powder substitution increases the ash content in the developed pasta in comparison with controlled as well as shallot waste extract added samples. This may be due to the higher mineral content in shallot wastes as compared with refined wheat flour [15]. The highest ash content was observed in sample added with shallot stalk powder at 20% substitution which accounted for 3.38±0.009% of ash content. Unlike shallot waste powder, shallot waste extract shared very less in terms of ash content in the developed pasta and the change remain non-significant (p=0.05) irrespective of waste stream.

3.1.6 Carbohydrate

The carbohydrate is the major part of pasta products which relative concentration is mainly dependent on the change in other nutrients. The analysis of the developed samples revealed the significant change in protein, fiber and ash, the similar trend was observed for the carbohydrate. Carbohydrate content showed inverse relation with other constituents and highest amount of it was observed in controlled sample (78.95±0.07%). Samples *viz*. PE-10, PE-20, SE-10 and SE-20 do not show any significant change in carbohydrate content and accounted for 78.89±0.08, 78.84±0.01, 78.75±0.06 and 78.62±0 respectively. However, sample added with shallot waste powder showed significant decrease.

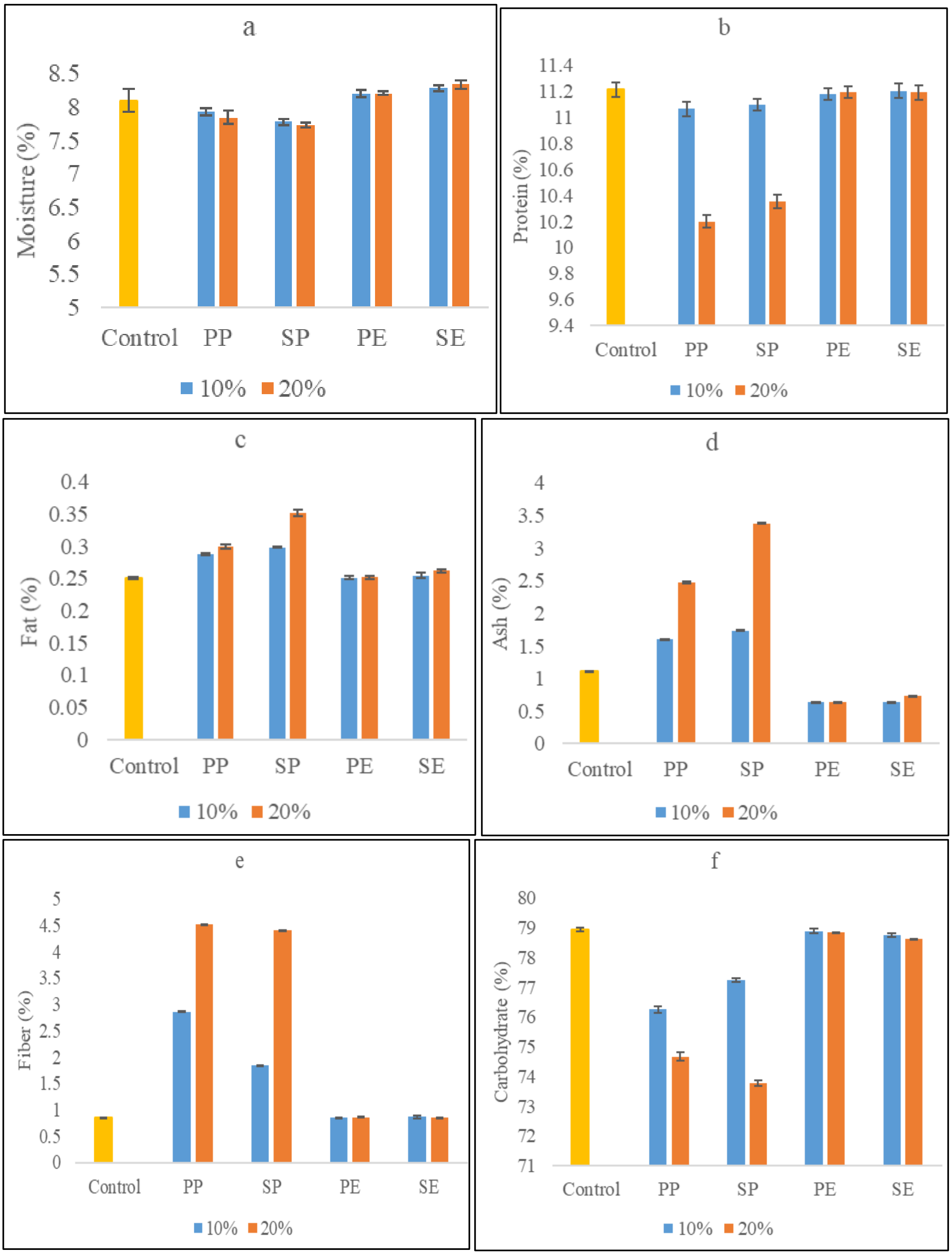

Fig 1: Composition of pasta developed with shallot waste powder and extract. a) Moisture, b) Protein, c) Fat, d) Ash, e) Fiber and e) Carbohydrate.

3.2 Energy value
Energy of the commodity is mainly dependent on its composition. Carbohydrate, protein and fat are the major nutrients that contribute to the energy value of developed pasta. As the composition of developed samples deviates significantly from controlled sample and similar changes were observed in energy value. Figure 2 represents the energy value of developed pasta and demonstrate very less change in energy value of samples added with shallot waste extract and significant decrease with degree of substitution of shallot waste powder. The highest amount of energy value was observed in control sample accounting for 362.90±0.47 kCal. The lowest energy value was observed for the sample with 20% substitution of shallot stalk this may be due higher amount of fiber and ash present in this sample [16].

3.3 Antioxidant
Antioxidant activity was analyzed using DPPH scavenging activity, which represents the ability of nutrients present in food to bind reactive oxygen species that forms during different metabolic activities in a cell. Among the analyzed sample, sample added with shallot peel powder showed maximum antioxidant activity at 20% substitution accounting 83.69±0.42. Though addition of shallot waste extract increases the antioxidant activity to lower concentration in comparison with direct substitution, it was nearly 6 folds

higher in 20% peel extract addition and 4 folds higher in 20% stalk extract addition. This makes it highly valuable product in terms of nutritional and health benefits. The main reason behind increased antioxidant activity could be several compounds present in shallot waste streams [4].

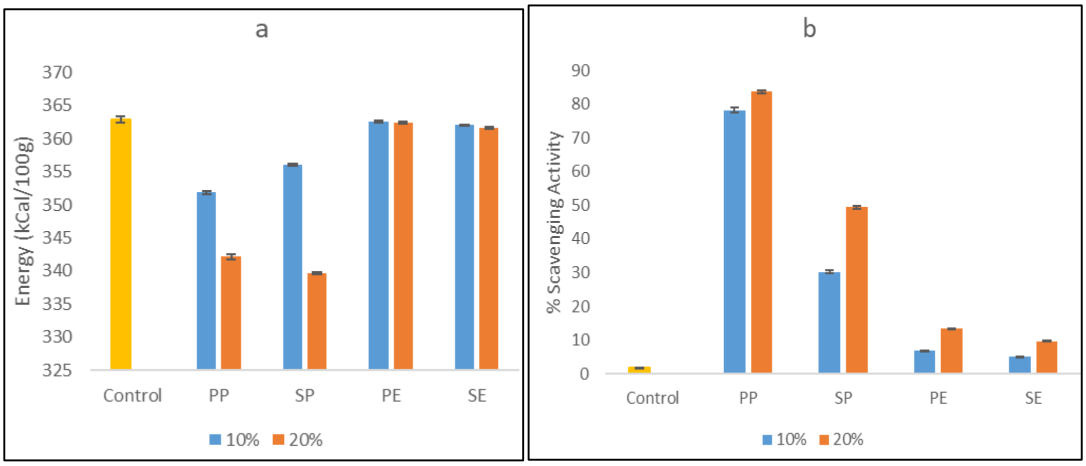

Fig 2: Energy value (a) and antioxidant activity (b) of developed pasta

3.4 Color

Substitution of shallot waste changes the color of developed pasta significantly in samples substituted with shallot waste powder. The change in color is mainly due to the dark color of shallot wastes which were substituted. The change in color in terms of L*, a* and b* were measured and the difference is measured as ΔE which are represented in table 2. The L* value decreased in all the samples and a* had increased as compared to controlled sample. This showed increased redness and decreased lightness.

Table 2: Color analysis on pasta developed with shallot waste substitution and extraction addition

	C	PP-10	PP-20	SP-10	SP-20	PE-10	PE-20	SE-10	SE-20
L*	54.56±0.27^{A}	28.85±0.43^{D}	19.61±0.4^{E}	31.31±0.8^{CD}	32.72±0.48^{C}	53.94±0.27^{A}	49.26±0.75^{B}	56±0.85^{A}	55.14±0.28^{A}
a*	4.81±0.02^{E}	6.96±0.14^{D}	9.18±0.05^{A}	7.05±0.18^{D}	7.67±0.08^{C}	6.99±0.07^{D}	8.36±0.04^{B}	4.22±0.09^{F}	5.15±0.05^{E}
b*	20.86±0.1^{B}	10.04±0.15^{D}	5.7±0.03^{E}	15.68±0.08^{C}	15.21±0.08^{C}	21.6±0.21^{B}	20.88±0.41^{B}	23.09±0.45^{A}	23.76±0.12^{A}
ΔE		27.98±0.37^{B}	38.35±0.03^{A}	23.93±0.23^{C}	22.74±0.39^{C}	2.45±0.07^{E}	6.39±0.2^{E}	2.74±0.28^{E}	2.97±0.11^{D}

Different letters represent the significant difference at p=0.05

3.5 Texture

The hardness of the developed shallot waste streams showed decline with respect to increased substitution. The fibers in shallot waste streams powder interfere with the structure of the starch and avoid the continuity on the retrogradation of starch. This resulting in lower structural integrity of the dried pasta sample. The results for the same are represented in figure 3. The similar results were observed by Bustos *et al.* [16]. The lowest hardness was observed in sample substituted with 20% of shallot peel and accounting to 5033.79±25.30 g force. The same sample showed highest amount of fiber too.

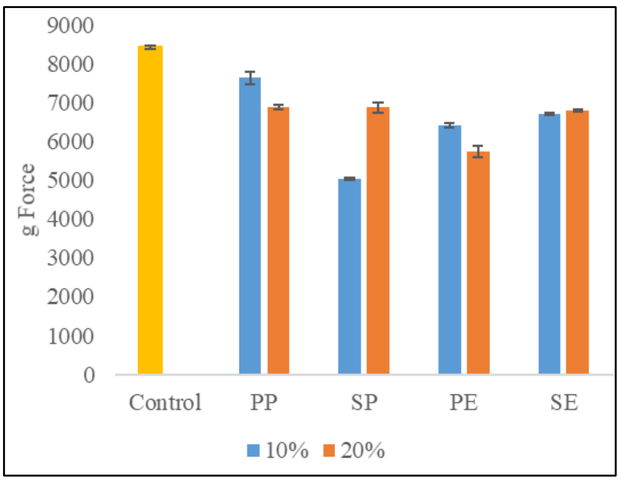

Fig 3: Hardness of developed pasta analyzed by texture analyzer.

3.6 Quercetin

Quercetin is a major constituent in shallot wastes. It is reported to have good anti-oxidant activity. Among developed pasta, samples with peel substitution and peel extract addition showed higher anti-oxidant activity than their counter parts. Similarly, the quercetin content was also found higher in shallot peel sample [15]. This justifies the higher antioxidant activity of developed pasta in comparison with controlled sample.

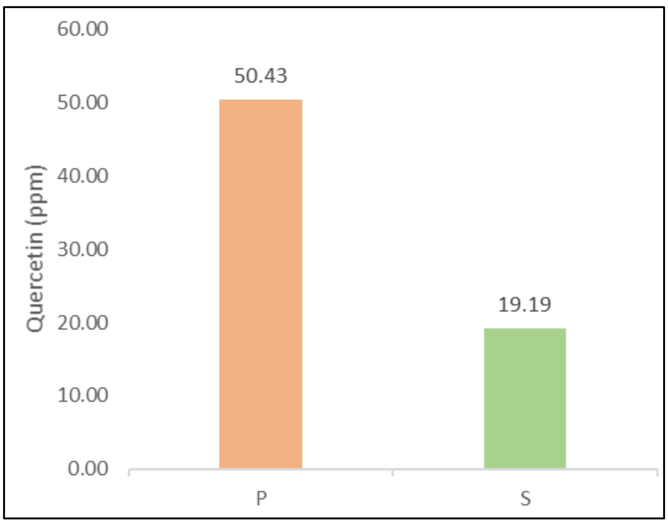

Fig 4: Quercetin content of shallot waste streams

4. Conclusion
The shallot waste powder can either be directly substituted with refined wheat flour or the extract can be used for improving the quality of pasta. Direct substitution of shallot waste powder in pasta limits the substitution to lower concentration due to drastic change in organoleptic properties which hampers the acceptability of final product. Whereas, extraction of desired components from shallot waste streams may lead to higher degree of addition and improving the quality of the food products. Substitution of shallot waste powder also changes the properties such as color, hardness and anti-oxidant activity. This substitution will lead to the development of value added products which have great demand in market due to health concerns and consumer preference. So, development of such value added products can provide farmers an additional income. Moreover, the utilization of these waste will reduce the burning and landfilling of these waste which as a result will avoid the air and land pollution caused by different gases and residues that transpire during burning and landfills.

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