Biological Forum – An International Journal 15(10): 1355-1365(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Standardization of Formulation for Preparation of Vegetable Enriched Pasta

Dev Raj[1], Maru Shveta M.[2], J. M. Mayani[3] and Gohil Mehul M.[4*]
[1]Professor and Head, Department of Post Harvest Technology,
ASPEE College of Horticulture, Navsari Agricultural University, Navsari (Gujarat), India.
[2]Research Scholar, Department of Post Harvest Technology,
ASPEE College of Horticulture, Navsari Agricultural University, Navsari (Gujarat), India.
[3]Assistance Professor, Department of Post Harvest Technology,
ASPEE College of Horticulture, Navsari Agricultural University, Navsari (Gujarat) India.
[4]Ph.D. Scholar, Department of Post Harvest Technology,
ASPEE College of Horticulture, Navsari Agricultural University, Navsari (Gujarat), India.

(Corresponding author: Gohil Mehul M.)*
(Received: 22 August 2023; Revised: 29 September 2023; Accepted: 07 October 2023; Published: 15 October 2023)
(Published by Research Trend)

ABSTRACT: Now a days, pasta is one of the most important and favourite food item among childers. However, due to presence/addition of some of the vegetable in pasta during the preparation causing on acceptability due to taste of vegetable in pasta. Moreover, the vegetable are very rich source of importance minerals and vitamins. So, to increase the acceptability of vegetable in pasta, the present investigation entitled "standardization of formulations for preparation of vegetable enriched pasta" was aimed to evaluate the nutritive quality of vegetable enriched pasta during storage. For preparation of vegetable enriched pasta, an experiment was laid out with seventeen treatment formulations of semolina flour (65, 63.5, 62.5 and 61.5 %), wheat flour (35, 34, 32.5 and 31%), capsicum powder (0, 2.5, 5 and 7.5 %), carrot juice (20, 15, 10 and 5%) and tomato juice (5, 10, 15 and 20%) along with standard formulation (100% semolina flour and 25% water) using completely randomized design. The prepared vegetable enriched pasta was stored for a period of 6 month to analyse the quality attributes at two month intervals. The results of the investigation revealed that best quality vegetable enriched pasta with higher sensory acceptability can be prepared using 63.5% semolina, 34% wheat flour, 2.5% capsicum powder, 5% carrot juice and 20% tomato juice. This formulation of pasta also resulted higher storage stability of nutritional parameters like vitamin C, ash content, starch content, lycopene content, carotene content during six months storage. Prepared pasta can be stored successfully for 6 months in polypropylene bag (480 gauge) at room temperature. The developed pasta technology can be commercially explored by the food processors for production quality of vegetable enriched pasta and helpful for profitable utilization of vegetables for harnessing of their nutraceuticals and aesthetic properties.

Keywords: Carrot, Capsicum, Tomato, Carotene, Lycopene.

INTRODUCTION

Pasta is a traditional extruded food product with origins dating back to the first century B.C. and is favoured by consumers for its ease of transportation, handling, cooking and storage properties. Thus, extrusion is highly efficient technique for food processing. Pasta products such as macaroni, spaghetti, vermicelli and noodles are manufactured from semolina. Pasta products are becoming popular in current life style because they are healthy, tasty and convenient for transportation and preparation. The perception of pasta consumption is changing and is now considered as an excellent low fat protein source that is convenient and nutritious.

There are more than 30 pasta brands available in the India and the market is expected to be around Rs. 250-300 crore. Traditionally pasta is being made using durum wheat (*Triticum durum* L.) semolina, which is rich in gluten protein. Celiac disease, wheat allergy disorders are caused by gluten. Besides this deficiencies of essential micronutrients ions or excesses of toxic ions in food are of concern. Therefore, options are being explored to replace or reduce wheat in diet for sensitive groups of people. The quality pasta is made of durum wheat semolina with a low enzyme activity and a yellowish colour. The substitution or addition of non - traditional ingredients in wheat flour may require compromise between nutritional enhancement and acceptable sensory properties of pasta. Modern active lifestyle necessitates development of functional pasta and noodles for better health and disease prevention. With appropriate selection and addition of food ingredients there is a great opportunity for developing pasta products having health benefits when consumed. Therefore, enrichment of pasta with different vegetables like carrot, tomato and capsicum increase the nutritional and vitamin content of the pasta.

Carrot (*Daucus carota* L.) is an important root vegetable crop cultivated extensively in the country particularly during winter season. The cultivation of carrot can be traced in Asia Minor in the 10th and 11th centuries. In India, the carrot is said to have been introduced from Persia. Carrot is known for its β-carotene and carotenoids content besides appreciable amounts of vitamin B_1, B_2, B_{12} and minerals (Syed *et al.*, 1986). Hundred grams of edible portion of carrot root contains 86g water, 0.9g protein, 0.2g fat, 10.6g carbohydrates, 1.2g fibre, 1890µg carotene, 3mg vitamin C, 48Kcal energy, 1.1g minerals, 2.2mg iron, 0.04mg thiamine, 0.02mg riboflavin, 0.5mg niacin, 15µg folic acid, 80mg calcium and 30mg phosphorus. Carrot is known to reduce cancer in animals by 40%. Carrot juice, with its rapid alkalizing effect, helps in controlling anaemia, liver trouble, acidosis, blood poisoning, circulatory disorders and ulcers. It also helps in treatment of ailments such as gall stones and gout. Carrot contains a plant hormone to cokinin which is closely analogous to insulin and has proved to be beneficial for diabetics, rheumatic ailments, which are often a result of poor nutrition, respond well to carrot juice.

Tomato is the second most important vegetable next to potato. Tomato is used to great extent in the fresh form and to some extent in the form of juice, puree, sauces etc. Tomatoes are low in calories but proportionately high in sugar. The tomato fruit contain many antioxidants such as carotenoids including lycopene and carotene, vitamin C and vitamin E and polyphenols (Giovanelli and Paradiso 2002). Tomatoes and tomato based foods are considered healthy foods as there are low in fat, sodium, calories, good source of fibre, contain significant amount of lycopene and beta carotene, vitamin C, traces of selenium, copper, manganese and zinc and contains micronutrients (Parafitt *et al.*, 1994). Tomato juice contains 93.1 per cent moisture, 4.89 per cent carbohydrate, vitamins, and minerals, and is low in protein and fat. The large amount of water also makes tomato fruits more perishable. Tomato fruit is a rich source of citric and mallic acids that contribute most to the typical taste of tomato fruit. Tomato juice is well recognized as one of the healthy beverages. Tomato is very popular because it adds variety of colors and flavors to the foods and helps to reduce risk of several important chronic diseases. Thus, incorporating tomato juice to pasta helps in getting all the nutritional benefits of it.

Sweet pepper (*Capsicum annuum* L.), commonly known as bell pepper, capsicum or Shimla mirch, is one of the important vegetable crops in India. The area under capsicum in India and Gujarat is 9565 and 42.2 thousand hectare and production is 945.5 and 15.0 thousand MT respectively. It is used as salad, cooked as vegetable, pickled or processed and is appreciated worldwide for its flavour, aroma and colour. It is an important source of pro-vitamin A (in the red stage) and vitamin C. Sweet peppers are the great choice of the food industries owing to its extensive use as a flavoring and coloring in sauces, soups, soft drinks, snacks, sweets, processed meats and alcoholic beverages. Additionally, the sweet peppers have been used as natural remedy for treating various diseases such as hypertension, inflammation, cancer, diabetes and cardiovascular diseases (Giuffrida *et al.*, 2013). Capsicums are important food additives in many parts of the world and valued for their sensory attributes of color and aroma (Contreras and Yahia 1998). Mostly venders are using bell pepper for imparting the peculiar flavour in pasta/noodles. Therefore, there is also good scope for addition of bell pepper in the pasta.

MATERIALS AND METHOD

A. Preparation of Ingredients

(i) Preparation of semolina and wheat flour. The both semolina and wheat flour were sieved through an 80-100 mesh sieve. The samples were kept in airtight containers until used.

(ii) Preparation of capsicum powder. Fresh green capsicum fruits were sorted and de-stalked manually and washed in running tap water to remove adhering dirt and dust particles. Then, the capsicums were immediately wiped with a table cloth to remove superficial moisture. After cleaning capsicum were cut into small pieces (4-5 mm × 15-20 mm) for drying. Pretreatment of capsicum was done by soaking immediately in the solution of KMS (0.20 %) andcitric acid (0.10 %) for 10 min and blanched at a temperature of 90°C for 1 min. Capsicum pieceswere then dehydrated in a cabinet dryer at 60°C until a final moisture content of around 8.5 % was obtained. During dehydration, trays of the dryer were altered from time to time to facilitate uniform drying. Thereafter, dried capsicum pieces were pulverized to prepare powder using grinder. Then the prepared powder was passed through a sieve (250 mesh) for obtaining fine capsicum powder. The screened powder was weighed and packed in PP pouch (polypropylene pouches). The powder was stored at room temperature until further use.

(iii) Preparation of carrot juice. The fresh carrots were sorted and washed in running tap water to remove adhering dirt and dust particles. Then, the carrots were immediately wiped with a table cloth to remove superficial moisture. Then, the carrots were cut into small pieces. Pretreatment of carrot as done by microwave heating for 1 min followed by crushing and juice extraction. Juice extraction was done using hydraulic press followed by pasteurization. After pasteurization, carrot juice was packed in PP pouch followed by heat processing at 100°C for 30 min. The carrot juice pouches were stored at -18°C temperature until further use.

(iv) Preparation of tomato juice. Fresh tomatowere sorted and de-stalked manually and washed in running tap water to remove adhering dirt and dust particles. Then, the tomato was immediately wiped with a table cloth to remove superficial moisture. Then, washed tomato was chopped into small pieces. Pretreatment was done by heating of chopped tomato for 2 min in pressure cooker. Then, juice extraction was done by pulper followed by pasteurization. After pasteurization, tomato juice was packed in PP pouch followed by heat processing at 100°C for 30 min. The tomato juice pouches were stored at -18°C temperature until further use.

B. Methodology Adopted for Preparation of Vegetable Enriched Pasta

After preparation of capsicum powder, carrot juice and tomato juice; vegetable enriched pasta was prepared using different proportion of semolina, wheat flour, capsicum powder, carrot juice and tomato juice. Water was used in standard formulation for preparation of pasta and kept as control. A total of seventeen different treatment formulations as detailed in Table 1 were used for preparation of pasta.

Table 1: Detail of treatment formulations used for preparation of vegetable enriched pasta.

Treatment	Semolina (g)	Wheat flour (g)	Capsicum powder (g)	Carrot juice (ml)	Tomato juice (ml)
T_1	650	350	0	200	50
T_2	650	350	0	150	100
T_3	650	350	0	100	150
T_4	650	350	0	50	200
T_5	635	340	25	200	50
T_6	635	340	25	150	100
T_7	635	340	25	100	150
T_8	635	340	25	50	200
T_9	625	325	50	200	50
T_{10}	625	325	50	150	100
T_{11}	625	325	50	100	150
T_{12}	625	325	50	50	200
T_{13}	615	310	75	200	50
T_{14}	615	310	75	150	100
T_{15}	615	310	75	100	150
T_{16}	615	310	75	50	200
T_{17}	1000 g Semolina flour + 250 ml Water (Control)				

Pasta of different formulations were prepared using pasta extruder by kneading the entire ingredient as per treatment combinations (Table 1) in feeding section followed by cold extrusion. The moisture content of around 25.0 % required for making pasta *via.* cold extrusion in pasta making machine was maintained while kneading and extrusion. Then, extruded pasta was dehydrated in dryer at 65°C temperature for 5 hour to remove moisture up to 5.5±0.1 % followed by cooling at room temperature, packing in 480 gauge PP bags and storage at room temperature for six months for periodical analysis. Principal steps used for preparation of vegetable enriched pasta are given in Fig. 1.

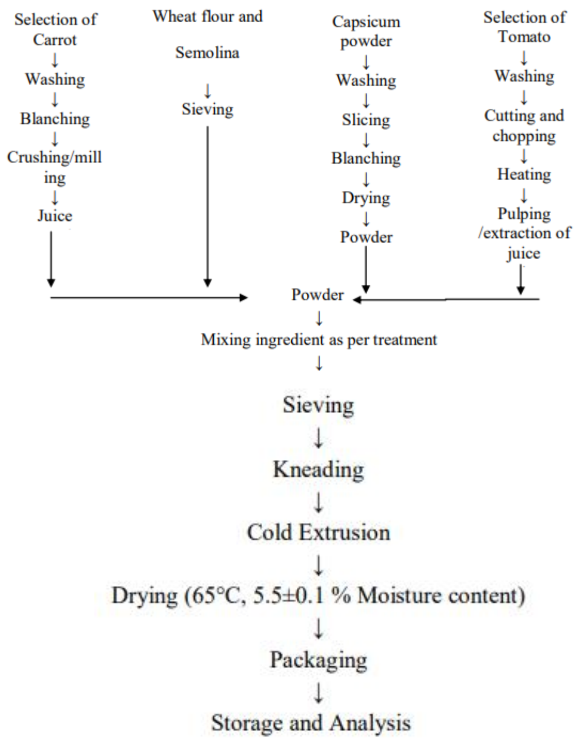

Fig. 1. Principal steps used for preparation of vegetable enriched pasta.

RESULTS AND DISCUSSION

A. Recovery

Data pertaining to effect of different treatment formulations on recovery of vegetable enriched pasta has been presented in Table 2.

Effect of different treatments: Data shows that among different formulations, the mean recovery of pasta (T) varied significantly between 79.97 to 77.63 %, with maximum recovery in pasta which were prepared using 61.5 % semolina, 31 % wheat flour, 7.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_{16}) and minimum in pasta prepared using 100 % semolina and 25 % water (T_{17}). The variation in recovery of the pasta is due to variation in the ingredients in the formulation. Higher content of capsicum powder, carrot juice and tomato juice total solids are responsible for higher yield in T_{16}. Similar variations in the treatment formulation due to variation in the ingredients were also observed by Vaghashiya (2018) for vermicelli.

Table 2: Effect of different treatment formulations on recovery per cent of vegetable enriched pasta.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Pasta recovery (%)
T_{1}: (65,35,0,20,5)	79.93
T_{2}: (65,35,0,15,10)	79.94
T_{3}: (65,35,0,10,15)	79.92
T_{4}: (65,35,0,5,20)	79.94
T_{5}: (63.5,34,2.5,20,5)	79.26
T_{6}: (63.5,34,2.5,15,10)	79.24
T_{7}: (63.5,34,2.5,10,15)	79.28
T_{8}: (63.5,34,2.5,5,20)	79.25
T_{9}: (62.5,32.5,5,20,5)	79.54
T_{10}: (62.5,32.5,5,15,10)	79.55
T_{11}: (62.5,32.5,5,10,15)	79.53
T_{12}: (62.5,32.5,5,5,20)	79.57
T_{13}: (61.5,31,7.5,20,5)	79.96
T_{14}: (61.5,31,7.5,15,10)	79.96
T_{15}: (61.5,31,7.5,10,15)	79.96
T_{16}: (61.5,31,7.5,5,20)	**79.97**
T_{17}: (SF100, W25)	77.63
SEm±	1.11
CD at 5%	3.19
CV %	2.42
*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water	

B. Moisture

Data pertaining to effect of different treatment formulations on moisture content of vegetable enriched pasta during six month storage has been presented in Table 3.

Effect of different treatments: Data shows that among different formulations, the mean moisture content of pasta (T) varied significantly between 6.21 to 7.17 %, with minimum moisture content in control pasta which were prepared using 100% semolina and 25 % water (T_{17}) and maximum in pasta prepared using 61.5 %semolina, 31 % wheat flour, 7.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_{16}). This might be due to increasing level of capsicum powder incorporation. Hydration properties, such as water absorption index and water solubility index of the wheat flour, significantly changed with the incorporation of different levels of red bell pepper powder. This may be due to the more water absorption capacity of red bell pepper powder owing to its dietary fiber content (Kaur *et al.*, 2020). Additions of vegetable pastes enhances the interaction between starch granules and protein matrix resulting in better quality pasta and have greater water holding capacity (Yadav *et al.*, 2014).

Effect of storage: During six month storage, the mean moisture content of pasta (S) increased significantly from 5.44 to 8.57 % (S_1 to S_4). It might be due to the weakening of the gluten network with storage time which would allow easier water penetration and increase in water absorption (Kaur *et al.*, 2012). Similar results were found by Yadav *et al.* (2014).

Table 3: Effect of different treatment formulations on moisture content (%) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Moisture (%)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	5.35	6.39	7.38	8.48	**6.90**
$T_{2: (65,35,0,15,10)}$	5.52	6.62	7.49	8.66	**7.07**
$T_{3: (65,35,0,10,15)}$	5.46	6.53	7.50	8.50	**7.00**
$T_{4: (65,35,0,5,20)}$	5.43	6.57	7.42	8.43	**6.96**
$T_{5: (63.5,34,2.5,20,5)}$	5.43	6.33	7.40	8.53	**6.92**
$T_{6: (63.5,34,2.5,15,10)}$	5.50	6.40	7.45	8.53	**6.97**
$T_{7: (63.5,34,2.5,10,15)}$	5.46	6.49	7.49	8.59	**7.01**
$T_{8: (63.5,34,2.5,5,20)}$	5.25	6.22	7.22	8.32	**6.75**
$T_{9: (62.5,32.5,5,20,5)}$	5.54	6.61	7.57	8.66	**7.10**
$T_{10: (62.5,32.5,5,15,10)}$	5.38	6.31	7.31	8.45	**6.86**
$T_{11: (62.5,32.5,5,10,15)}$	5.54	6.61	7.48	8.68	**7.08**
$T_{12: (62.5,32.5,5,5,20)}$	5.52	6.55	7.45	8.65	**7.04**
$T_{13: (61.5,31,7.5,20,5)}$	5.59	6.59	7.62	8.72	**7.13**
$T_{14: (61.5,31,7.5,15,10)}$	5.63	6.54	7.67	8.76	**7.15**
$T_{15: (61.5,31,7.5,10,15)}$	5.65	6.59	7.62	8.75	**7.15**
$T_{16: (61.5,31,7.5,5,20)}$	5.66	6.68	7.58	8.74	**7.17**
$T_{17: (SF100, W25)}$	4.52	5.59	6.42	8.29	**6.21**
Mean (S)	**5.44**	**6.45**	**7.42**	**8.57**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.065	0.19	Main plot factor = 3.22		
Storage (S)	0.015	0.04	Sub plot factor = 1.61		
Interaction T×S	0.064	0.18			

*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water

C. TSS

Data pertaining to effect of different treatment formulations on TSS of vegetable enriched pasta during six months storage has been presented in Table 4.

Effect of different treatments: Data shows that among different treatment formulations, the mean TSS of pasta (T) varied significantly between 14.70 to 11.60 °B, with maximum TSS in pasta which were prepared using 61.5%semolina, 31% wheat flour, 7.5% capsicum powder, 5% carrot juice and 20% tomato juice (T_{16}) which remained statistically at par with formulations T_{13}, T_{14} and T_{15} and minimum TSS in pasta prepared using 100% semolina and 25% water (T_{17}). The maximum TSS in T_{16} treatment might be due to higher found in capsicum powder. Vaghashiya (2018) observed that higher TSS content in formulation F_2(24 % *Aloe vera* + 5 % isabgol husk + 74.5 % wheat flour) due to the higher TSS in wheat flour and isabgol husk than *Aloe vera* juice.

Effect of storage: During six months storage, the mean TSS of vegetable enriched pasta (S) increased significantly from 13.85 to 13.99 °B (S_1 to S_4). The increase in TSS might be due to inversion of polysaccharides like starch and cellulose into simpler soluble molecules in the presence of organic acid (Sudhindra *et al.*, 2012). The hydrolysis of polysaccharides into mono-saccharides and oligosaccharides causes gradual increase in TSS during storage (Singh and Gaikwad 2012).

Table 4: Effect of different treatment formulations on TSS (°Brix) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	TSS (°Brix)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	13.42	13.51	13.57	13.57	**13.52**
$T_{2: (65,35,0,15,10)}$	13.41	13.49	13.53	13.56	**13.50**
$T_{3: (65,35,0,10,15)}$	13.38	13.42	13.46	13.49	**13.44**
$T_{4: (65,35,0,5,20)}$	13.44	13.53	13.57	13.61	**13.54**
$T_{5: (63.5,34,2.5,20,5)}$	13.84	13.88	13.93	13.95	**13.90**
$T_{6: (63.5,34,2.5,15,10)}$	13.82	13.89	13.92	13.94	**13.89**
$T_{7: (63.5,34,2.5,10,15)}$	13.89	13.93	13.95	13.98	**13.94**
$T_{8: (63.5,34,2.5,5,20)}$	13.85	13.88	13.90	13.94	**13.89**
$T_{9: (62.5,32.5,5,20,5)}$	14.13	14.19	14.23	14.26	**14.20**
$T_{10: (62.5,32.5,5,15,10)}$	14.18	14.25	14.30	14.31	**14.26**
$T_{11: (62.5,32.5,5,10,15)}$	14.21	14.23	14.27	14.30	**14.25**
$T_{12: (62.5,32.5,5,5,20)}$	14.11	14.18	14.22	14.25	**14.19**
$T_{13: (61.5,31,7.5,20,5)}$	14.55	14.62	14.65	14.67	**14.62**
$T_{14: (61.5,31,7.5,15,10)}$	14.59	14.64	14.69	14.77	**14.67**
$T_{15: (61.5,31,7.5,10,15)}$	14.57	14.63	14.69	14.75	**14.66**
$T_{16: (61.5,31,7.5,5,20)}$	14.61	14.68	14.72	14.79	**14.70**
$T_{17: (SF100, W25)}$	11.51	11.59	11.63	11.66	**11.60**
Mean (S)	**13.85**	**13.91**	**13.95**	**13.99**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.107	0.31	Main plot factor = 3.75		
Storage (S)	0.025	0.07	Sub plot factor = 1.85		
Interaction T×S	0.106	NS			

*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water

D. Ash Content

Data pertaining to effect of different treatment formulations on ash content of vegetable enriched pasta during six month storage has been presented in Table 5.

Effect of different treatments: Data shows that among different formulations, the mean ash content of pasta (T) varied significantly between 1.399 to 1.136 %, with maximum ash content in pasta prepared using 100 % semolina and 25 % water (T_{17}) and minimum ash content in pasta which were prepared using 63.5 %semolina, 34 % wheat flour, 2.5 % capsicum powder, 20 % carrot juice and 5 % tomato juice (T_5) and 63.5 % semolina, 34 % wheat flour, 2.5 % capsicum powder, 10 % carrot juice and 15 % tomato juice (T_7). Higher ash content in T_{17} might be due to higher ash content found in semolina. Further, the addition of capsicum powder also observed to increase the ash content, which might be due to higher ash content in capsicum powder than wheat flour. Qaisrani *et al.* (2014) reported variation in total ash in the treatments from control (1.17±0.01%) to cookies containing 25 % psyllium husk (1.70±0.02 %). Raymundo *et al.* (2014) demonstrated similar results. The ash content increased in the bread samples prepared with the incorporation of red bell pepper powder (Kaur *et al.*, 2020).

Effect of storage: During six months storage, the mean ash content of vegetable enriched pasta (T) decreased non-significantly from 1.168 to 1.155 % (S_1 to S_4). Qaisrani *et al.* (2014) observed that non-significant effect of storage on ash content of dietetic cookies prepared by straight grade flour was replaced with psyllium husk.

Table 5: Effect of different treatment formulations on ash content (%) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Ash content (%)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	1.163	1.160	1.157	1.153	**1.158**
$T_{2: (65,35,0,15,10)}$	1.160	1.155	1.150	1.147	**1.153**
$T_{3: (65,35,0,10,15)}$	1.163	1.157	1.153	1.149	**1.156**
$T_{4: (65,35,0,5,20)}$	1.167	1.162	1.161	1.157	**1.162**
$T_{5: (63.5,34,2.5,20,5)}$	1.147	1.140	1.130	1.125	**1.136**
$T_{6: (63.5,34,2.5,15,10)}$	1.143	1.140	1.136	1.131	**1.138**
$T_{7: (63.5,34,2.5,10,15)}$	1.143	1.137	1.133	1.129	**1.136**
$T_{8: (63.5,34,2.5,5,20)}$	1.140	1.138	1.137	1.132	**1.137**
$T_{9: (62.5,32.5,5,20,5)}$	1.150	1.147	1.143	1.138	**1.145**
$T_{10: (62.5,32.5,5,15,10)}$	1.153	1.148	1.145	1.141	**1.147**
$T_{11: (62.5,32.5,5,10,15)}$	1.150	1.143	1.139	1.134	**1.142**
$T_{12: (62.5,32.5,5,5,20)}$	1.150	1.146	1.142	1.138	**1.144**
$T_{13: (61.5,31,7.5,20,5)}$	1.157	1.150	1.146	1.143	**1.149**
$T_{14: (61.5,31,7.5,15,10)}$	1.155	1.152	1.148	1.147	**1.151**
$T_{15: (61.5,31,7.5,10,15)}$	1.156	1.153	1.149	1.145	**1.151**
$T_{16: (61.5,31,7.5,5,20)}$	1.154	1.152	1.147	1.143	**1.149**
$T_{17: (SF100, W25)}$	1.407	1.403	1.400	1.384	**1.399**
Mean (S)	**1.168**	**1.164**	**1.160**	**1.155**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.016	0.05	Main plot factor = 4.71		
Storage (S)	0.001	NS	Sub plot factor = 0.84		
Interaction T×S	0.005	NS			
*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water					

E. Carotene Content

Data pertaining to effect of different treatment formulations on carotene content of vegetable enriched pasta during six month storage has been presented in Table 6.

Effect of different treatments: Data shows that among different formulations, the mean carotene content of pasta (T) varied significantly between 142.83 to 109.76μg/100g, with maximum carotene content in pasta which were prepared using 61.5 % semolina, 31 % wheat flour, 7.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_{16}) and minimum in pasta prepared using 65 % semolina, 35 % wheat flour, 5 % carrot juice and 20 % tomato juice (T_4). This might be due to presence of higher carotene content in carrot juice and capsicum powder. While, no carotene content was observed in the pasta prepared using semolina alone (T_{17}), which is due to absence of carotene source. Lee *et al.* (2002) resulted that adding more pumpkin powder increased the level of β-carotene in the noodles.

Effect of storage: During six months storage, the mean carotene content of vegetable enriched pasta (T) decreased significantly from 136.11 to 105.84 μg/100g (S_1 to S_4). The pattern of decreasing of carotene during storage might be due to oxidative breakdown, isomerization or enzymatic destruction of pigments and increasing temperature at ambient condition during storage. The carotene is also sensitive to heat same as an ascorbic acid. It was also noticed that the decrease in carotene content during storage may be attributed to its sensitivity to light and oxygen. Pesek and Warthesen (1990) also found that β-carotene concentration decreased with increasing storage temperature in an aqueous model system. β-carotene content of carrot candy was found to decrease during six month storage as reported by Naik (2021).

Table 6: Effect of different treatment formulations on carotene content (µg/100g) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Carotene content (µg/100g)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	137.53	127.23	113.87	102.53	**120.29**
$T_{2: (65,35,0,15,10)}$	133.07	124.90	110.07	100.00	**117.01**
$T_{3: (65,35,0,10,15)}$	128.67	118.17	111.00	95.33	**113.29**
$T_{4: (65,35,0,5,20)}$	125.10	119.50	104.10	90.33	**109.76**
$T_{5: (63.5,34,2.5,20,5)}$	152.77	144.83	130.43	117.77	**136.45**
$T_{6: (63.5,34,2.5,15,10)}$	144.57	134.50	114.17	110.90	**126.03**
$T_{7: (63.5,34,2.5,10,15)}$	139.27	129.83	115.73	104.93	**122.44**
$T_{8: (63.5,34,2.5,5,20)}$	136.33	125.50	111.67	108.33	**120.46**
$T_{9: (62.5,32.5,5,20,5)}$	155.67	147.67	128.67	121.33	**138.34**
$T_{10: (62.5,32.5,5,15,10)}$	152.00	142.00	126.33	118.00	**134.58**
$T_{11: (62.5,32.5,5,10,15)}$	149.67	137.67	121.33	116.67	**131.34**
$T_{12: (62.5,32.5,5,5,20)}$	143.33	135.67	122.67	110.00	**127.92**
$T_{13: (61.5,31,7.5,20,5)}$	157.33	148.33	136.67	129.00	**142.83**
$T_{14: (61.5,31,7.5,15,10)}$	154.33	144.33	128.33	126.33	**138.33**
$T_{15: (61.5,31,7.5,10,15)}$	152.50	143.00	126.50	124.17	**136.54**
$T_{16: (61.5,31,7.5,5,20)}$	151.67	142.50	128.33	123.67	**136.54**
$T_{17: (SF100, W25)}$	0.00	0.00	0.00	0.00	**0.00**
Mean (S)	**136.11**	**127.39**	**113.52**	**105.84**	
	SEm±	CD at 5%	CV %		
Treatments (T)	0.95	2.73	Main plot factor = 2.57		
Storage (S)	0.42	1.17	Sub plot factor = 2.32		
Interaction FS	1.71	4.80			

*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water

F. Crude Fibre

Data pertaining to effect of different treatment formulations on crude fibre content of vegetable enriched pasta during six month storage has been presented in Table 7.

Effect of different treatments: Data shows that among different formulations, the mean crude fibre content of pasta (T) varied significantly between 1.887 to 3.466 %, with maximum crude fibre content in pasta which were prepared using 61.5 %semolina, 31 % wheat flour, 7.5 % capsicum powder, 15 % carrot juice and 10 % tomato juice (T_{14}) and 61.5 % semolina, 31 % wheat flour, 7.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_{16}) which remained statistically at par with formulations T_{13} and $T_{15}$and minimum crude fibre content in pasta prepared using 65 %semolina, 35 % wheat flour, 5 % carrot juice and 20 % tomato juice (T_4). This might be due to higher fibre content present in semolina and capsicum powder. Qaisrani *et al.* (2014) observed maximum fibre in cookies which were prepared with psyllium husk as a source of fibre.

Effect of storage: During six months storage, the mean crude fibre content of vegetable enriched pasta (S) decreased non-significantly from 2.596 to 2.588 % (S_1 to S_4). The slight decrease in fibre content during storage might be due to hydrolysis of polysaccharides into mono-saccharides or simple sugars. Aslam *et al.* (2014) for mango peel and kernel based biscuits, Kakali *et al.* (2014) for mango peel and kernel fortified biscuits, Ajila *et al.* (2008); Ahmad (2017) for mango peel powder biscuits.

Table 7: Effect of different treatment formulations on crude fibre content (%) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Crude fibre (%)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	1.813	1.810	1.809	1.805	**1.809**
$T_{2: (65,35,0,15,10)}$	1.807	1.805	1.802	1.800	**1.804**
$T_{3: (65,35,0,10,15)}$	1.810	1.809	1.805	1.802	**1.807**
$T_{4: (65,35,0,5,20)}$	1.813	1.811	1.811	1.805	**1.810**
$T_{5: (63.5,34,2.5,20,5)}$	2.362	2.359	2.357	2.355	**2.358**
$T_{6: (63.5,34,2.5,15,10)}$	2.363	2.360	2.357	2.355	**2.359**
$T_{7: (63.5,34,2.5,10,15)}$	2.361	2.357	2.354	2.354	**2.357**
$T_{8: (63.5,34,2.5,5,20)}$	2.363	2.360	2.357	2.356	**2.359**
$T_{9: (62.5,32.5,5,20,5)}$	2.919	2.915	2.912	2.912	**2.915**
$T_{10: (62.5,32.5,5,15,10)}$	2.918	2.914	2.911	2.909	**2.913**
$T_{11: (62.5,32.5,5,10,15)}$	2.921	2.917	2.914	2.913	**2.916**
$T_{12: (62.5,32.5,5,5,20)}$	2.917	2.914	2.917	2.909	**2.914**
$T_{13: (61.5,31,7.5,20,5)}$	3.469	3.465	3.463	3.461	**3.465**
$T_{14: (61.5,31,7.5,15,10)}$	3.470	3.467	3.464	3.462	**3.466**
$T_{15: (61.5,31,7.5,10,15)}$	3.468	3.465	3.462	3.461	**3.464**
$T_{16: (61.5,31,7.5,5,20)}$	3.470	3.467	3.464	3.462	**3.466**
$T_{17: (SF100, W25)}$	1.893	1.889	1.886	1.880	**1.887**
Mean (S)	**2.596**	**2.593**	**2.591**	**2.588**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.013	0.04	Main plot factor = 1.72		
Storage (S)	0.004	NS	Sub plot factor = 1.22		
Interaction T×S	0.018	NS			

*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water

G. Vitamin C

Data pertaining to effect of different treatment formulations on vitamin C content of vegetable enriched pasta during six month storage has been presented in Table 8.

Effect of different treatments: Data shows that among different formulations, the mean vitamin C content of pasta (T) varied significantly between 45.41 to 32.27mg/100g, with maximum vitamin C in pasta prepared using 61.5 % semolina, 31 % wheat flour, 7.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_{16})which remained statistically at par with formulations T_{10}, T_{11}, T_{13}, T_{14} and T_{15} and minimum vitamin C content in pasta which were prepared using 100 % semolina and 25% water (T_{17}). Highest vitamin C content in pasta might be attributed to increase in level of capsicum powder. Antioxidant activity increased with increasing level of capsicum juice which is a rich source of antioxidant (Cortes *et al.*, 2020). Similar results were found by (Mridula *et al.*, 2015).

Effect of storage: During six months storage, the mean vitamin C content of vegetable enriched pasta(S) decreased significantly from 45.73 to 40.14mg/100g (S_1 to S_4). Ascorbic acid content decreased with the advancement of storage period which may be due to effect of light and oxidation at ambient condition during storage. Similar results were observed by Naik (2021) for carrot candy.

Table 8: Effect of different treatment formulations on vitamin C (mg/100g) content of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Vitamin C (mg/100g)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
$T_{1: (65,35,0,20,5)}$	45.43	44.09	41.55	39.14	**42.55**
$T_{2: (65,35,0,15,10)}$	45.56	44.21	41.67	39.28	**42.68**
$T_{3: (65,35,0,10,15)}$	45.68	44.37	41.78	39.37	**42.80**
$T_{4: (65,35,0,5,20)}$	45.92	44.55	41.89	39.41	**42.94**
$T_{5: (63.5,34,2.5,20,5)}$	45.53	44.52	41.99	39.68	**42.93**
$T_{6: (63.5,34,2.5,15,10)}$	45.62	44.69	42.09	39.75	**43.04**
$T_{7: (63.5,34,2.5,10,15)}$	45.89	44.42	42.18	39.75	**43.04**
$T_{8: (63.5,34,2.5,5,20)}$	46.11	44.98	42.83	41.97	**43.97**
$T_{9: (62.5,32.5,5,20,5)}$	46.57	45.45	43.18	41.55	**44.19**
$T_{10: (62.5,32.5,5,15,10)}$	46.68	45.53	43.29	41.67	**44.29**
$T_{11: (62.5,32.5,5,10,15)}$	46.75	45.65	43.41	41.78	**44.40**
$T_{12: (62.5,32.5,5,5,20)}$	46.98	45.73	43.57	40.47	**44.19**
$T_{13: (61.5,31,7.5,20,5)}$	47.24	46.51	44.52	41.99	**45.07**
$T_{14: (61.5,31,7.5,15,10)}$	47.29	46.69	44.69	42.09	**45.19**
$T_{15: (61.5,31,7.5,10,15)}$	47.43	46.75	44.81	42.18	**45.29**
$T_{16: (61.5,31,7.5,5,20)}$	47.55	46.87	44.98	42.23	**45.41**
$T_{17: (SF100, W25)}$	35.19	33.94	30.01	29.93	**32.27**
Mean (S)	**45.73**	**44.64**	**42.26**	**40.14**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.48	1.21	Main plot factor = 3.85		
Storage (S)	0.10	0.28	Sub plot factor = 1.71		
Interaction T×S	0.42	NS			
*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water					

H. Lycopene Content

Data pertaining to effect of different treatment formulations on lycopene content of vegetable enriched pasta during six month storage has been presented in Table 9.

Effect of different treatments: Data shows that among different formulations, the mean lycopene content of pasta (T) varied significantly between 0.148 mg/100g to 0.108 mg/100g, with maximum in pasta prepared using 63.5 % semolina, 34 % wheat flour, 2.5 % capsicum powder, 5 % carrot juice and 20 % tomato juice (T_8) and minimum lycopene content in pasta which were prepared using 61.5 % semolina, 31 % wheat flour, 7.5 % capsicum powder, 20 % carrot juice and 5 % tomato juice (T_{13}). This might be due to presence of higher lycopene content in tomato juice. While, no lycopene was observed in the pasta prepared using semolina alone (T_{17}), which is due to absence of lycopene source. Rekha *et al.* (2013) found that the addition of carrot, spinach, tomato and beetroot purees increased levels of carotene, -lycopene, betalain content compared to control pasta.

Effect of storage: During six months storage, the mean lycopene content of vegetable enriched pasta (S) decreased significantly from 0.136 to 0.098 mg/100g (S_1 to S_4). This might be due to temperature plays an important role in lycopene loss during storage. Dehydrated tomato products are sensitive to color fading and loss of acceptability mainly due to lycopene isomerization and oxidation (Xianquan *et al.*, 2005). Similar study of Sharma and Maguer (1996) found that after 4 months storage at room temperature, in the dark condition, the lycopene loss observed 97% in freeze-dried and 79% in oven-dried tomato pulp. Ribeiro *et al.* (2003) also showed that lycopene stability strongly depends on the food system.

Table 9: Effect of different treatment formulations on lycopene content (mg/100g) of vegetable enriched pasta during storage.

Treatments ($T_{SF, WF, CP, CJ, TJ}$)	Lycopene content (mg/100g)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
T_1: (65,35,0,20,5)	0.140	0.136	0.123	0.106	**0.126**
T_2: (65,35,0,15,10)	0.146	0.138	0.121	0.111	**0.129**
T_3: (65,35,0,10,15)	0.155	0.145	0.126	0.106	**0.133**
T_4: (65,35,0,5,20)	0.152	0.148	0.129	0.101	**0.133**
T_5: (63.5,34,2.5,20,5)	0.152	0.143	0.125	0.105	**0.131**
T_6: (63.5,34,2.5,15,10)	0.153	0.143	0.130	0.125	**0.138**
T_7: (63.5,34,2.5,10,15)	0.155	0.146	0.125	0.122	**0.137**
T_8: (63.5,34,2.5,5,20)	0.156	0.149	0.145	0.140	**0.148**
T_9: (62.5,32.5,5,20,5)	0.138	0.128	0.114	0.099	**0.120**
T_{10}: (62.5,32.5,5,15,10)	0.140	0.126	0.112	0.103	**0.120**
T_{11}: (62.5,32.5,5,10,15)	0.149	0.134	0.116	0.101	**0.125**
T_{12}: (62.5,32.5,5,5,20)	0.153	0.139	0.120	0.101	**0.128**
T_{13}: (61.5,31,7.5,20,5)	0.125	0.119	0.101	0.087	**0.108**
T_{14}: (61.5,31,7.5,15,10)	0.129	0.118	0.111	0.086	**0.111**
T_{15}: (61.5,31,7.5,10,15)	0.131	0.124	0.114	0.085	**0.114**
T_{16}: (61.5,31,7.5,5,20)	0.140	0.125	0.110	0.088	**0.116**
T_{17}: (SF100, W25)	0.000	0.000	0.000	0.000	**0**
Mean (S)	**0.136**	**0.127**	**0.113**	**0.098**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.0011	0.003	Main plot factor = 2.51		
Storage (S)	0.0004	0.001	Sub plot factor = 2.45		
Interaction T×S	0.0018	0.005			
*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water					

I. Starch

Data pertaining to effect of different treatment formulations on starch content of vegetable enriched pasta during six month storage has been presented in Table 10.

Effect of different treatments: Data shows that among different formulations, the mean starch content of pasta (T) varied significantly between 81.66 to 71.15 %, with maximum in pasta prepared using 100 % semolina and 25 % water (T_{17}) and minimum starch content in pasta which were prepared using 61.5 %semolina, 31 % wheat flour, 7.5 % capsicum powder, 10 % carrot juice and 15 % tomato juice (T_{15}). This might be due to presence of higher starch content in semolina. Similarly, Garcia *et al.* (2021) found that the pasta formulation was made only with semolina, contains a large amount of starch (about 74.67 ± 0.95 g/100g d.b.).

Effect of storage: During six months storage, the mean starch content of vegetable enriched pasta (S) decreased non-significantly from 73.99 to 73.83 % (S_1 to S_4). Gandhi (2009) reported that wheat porridge have significantly higher starch content (58.67%) followed by 30% mango pulp incorporated instant wheat porridge (57.06 %) and significantly lower starch content (54.66 %) found in porridge incorporated with 40% mango pulp. Similar results were found by Shukla and Srivastava (2011). Similarly during six months storage, the mean starch content of vermicelli (S) decreased non-significantly were also observed by Vaghashiya (2018).

Table 10: Effect of different treatment formulations on starch (%) content of vegetable enriched pasta during storage.

Treatments (T)	Starch (%)				
	Storage (S)				Mean (T)
	Initial (S_1)	2 month (S_2)	4 month (S_3)	6 month (S_4)	
T_1: (65,35,0,20,5)	75.82	75.82	75.75	75.70	**75.77**
T_2: (65,35,0,15,10)	75.83	75.81	75.72	75.69	**75.76**
T_3: (65,35,0,10,15)	75.81	75.80	75.66	75.60	**75.72**
T_4: (65,35,0,5,20)	75.84	75.86	75.65	75.59	**75.74**
T_5: (63.5,34,2.5,20,5)	74.26	74.24	74.13	74.05	**74.17**
T_6: (63.5,34,2.5,15,10)	74.28	74.23	74.21	74.15	**74.22**
T_7: (63.5,34,2.5,10,15)	74.24	74.23	74.18	74.12	**74.19**
T_8: (63.5,34,2.5,5,20)	74.28	74.24	74.23	74.18	**74.23**
T_9: (62.5,32.5,5,20,5)	72.74	72.73	72.62	72.58	**72.67**
T_{10}: (62.5,32.5,5,15,10)	72.76	72.70	72.64	72.60	**72.68**
T_{11}: (62.5,32.5,5,10,15)	72.68	72.54	72.53	72.45	**72.55**
T_{12}: (62.5,32.5,5,5,20)	72.69	72.64	72.60	72.59	**72.63**

$T_{13: (61.5,31,7.5,20,5)}$	71.24	71.22	71.10	71.10	**71.17**
$T_{14: (61.5,31,7.5,15,10)}$	71.21	71.18	71.15	71.08	**71.16**
$T_{15: (61.5,31,7.5,10,15)}$	71.23	71.22	71.10	71.05	**71.15**
$T_{16: (61.5,31,7.5,5,20)}$	71.22	71.17	71.14	71.11	**71.16**
$T_{17: (SF100, W25)}$	81.78	81.77	81.60	81.50	**81.66**
Mean (S)	**73.99**	**73.96**	**73.88**	**73.83**	
	SEm±	**CD at 5%**	**CV %**		
Treatments (T)	0.73	2.10	Main plot factor = 3.42		
Storage (S)	0.15	NS	Sub plot factor = 1.49		
Interaction T×S	0.63	NS			
*SF: Semolina flour; WF: Wheat flour; CP: Capsicum powder; CJ: Carrot juice; TJ: Tomato juice; W: Water					

CONCLUSIONS

Based on the finding, best quality vegetable enriched pasta can be prepared using 63.5% semolina, 34% wheat flour, 2.5% capsicum powder, 5% carrot juice and 20% tomato juice. This formulation of pasta also resulted higher storage stability of nutritional parameters like vitamin C, ash content, starch content, lycopene content, carotene content during six months storage. Prepared pasta can be stored successfully for 6 months in polypropylene bag (480 gauge) at room temperature. Thus, the developed pasta technology can be commercially explored by the food processors for production quality of vegetable enriched pasta and helpful for profitable utilization of vegetables for harnessing of their nutraceuticals and aesthetic properties.

FUTURE SCOPE

The vegetable enriched pasta possess very good scope for Commercialization at industry level to harnessing the nutraceuticals and aesthetic properties of vegetables.

REFERENCES

Ahmad, T. Q. (2017). Utilization of mango (*Mangifera indica* L.) processing industry waste for value addition. *Ph.D. Thesis*, Navsari Agricultural University, Navsari.

Ajila, C. M., Leelavathi, K. U. J. S. and Rao, U. P. (2008). Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *J. cereal sci.*, *48*(2), 319-326.

Aslam, H. K. W., Raheem, M. I. U., Ramzan, R., Shakeel, A., Shoaib, M. and Sakandar, H. A. (2014). Utilization of mango waste material (peel, kernel) to enhance dietary fiber content and antioxidant properties of biscuit. *J. Glob. Innov. Agric. Soc. Sci.*, *2*(2), 76-81.

Contreras, P. M. and Yahia, E. M. (1998). Changes in capsaicinoids during development, maturation, and senescence of chili peppers and relation with peroxidase activity. *J. Agric. Food Chem.*, *46*(6), 2075-2079.

Cortes, E. C. E., Gallardo, V. T., Osorio, R. G., Castaneda, P. E., Meza, M. O. G., Socorro, L. C. M. and Hernandez, M. D. M. (2020). Prediction of total phenolics, ascorbic acid, antioxidant capacities and total soluble solids of bell pepper (*Capsicum annuum* L.) juice by FT-MIR and multivariate analysis. *LWT-Food Sci. Technol.*, *126*, 1-10.

Gandhi, N. (2009). Development of fruit incorporated instant wheat porridge. *M.Sc. Thesis*, Punjab Agricultural University, Punjab.

Garcia, V. D. E., Bello, P. L. A., Agama, A. E. and Alvarez, R. J. (2021). Structural characteristics and in vitro starch digestibility of pasta made with durum wheat semolina and chickpea flour. *LWT-Food Sci. Technol.*, *145*, 111-347.

Giovanelli, G. and Paradiso, A. (2002). Stability of dried and intermediate moisture tomato pulp during storage. *J. Agric. Food Chem.*, *50*(25), 7277-7281.

Giuffrida, A. D., Dugo, P., Torre, G.; Bignardi, C., Cavazza, A., Corradini, C. and Dugo, G. (2013). Characterization of 12 Capsicum varieties by evaluation of their carotenoid profile and pungency determination. *Food Chem.*, *14*, 794-802.

Kakali, B., Chaitali, C. and Sagarika, B. (2014). Fortification of Mango Peel and Kernel Powder in Cookies Formulation. *J. Academia Indu. Res.*, *2*(12), 661- 664.

Kaur, G., Sharma, S., Nagi, H. P. S. and Dar, B. N. (2012). Functional properties of pasta enriched with variable cereal brans. *J. Food Sci. Technol.*, *49*, 467–474.

Kaur, R., Kaur, K., Wagh, R. V., Kaur, A. and Aggarwal, P. (2020). Red bell pepper (*Capsicum annuum* L.): Optimization of drying conditions and preparation of functional bread. *J. Food Sci.*, *85*(8), 2340-2349.

Lee, C. H., Cho, J. K., Lee, S. J., Koh, W., Park, W. and Kim, C. H. (2002). Enhancing β-carotene content in Asian noodles by adding pumpkin powder. *Cereal chem.*, *79*(4), 593-595.

Mridula, D, Gupta, R. K., Khaira, H. and Bhadwal, S. (2015). Groundnut Meal and carrot fortified pasta: optimization of ingredients level using RSM. *Proc. Natl. Acad. Sci. India. Sect. B. Biol. Sci.*, *87*(2), 277-288.

Naik, P. (2021). Standardization of technology for preparation of carrot (*Daucus carota* L.) candy. *M.Sc. Thesis*, Navsari Agricultural University, Navsari. 79 p.

Parfitt, V. J., Rubba, P., Bolton, C., Marotta, G., Hartog, M. and Mancinl, M. (1994). A comparison of antioxidant status and free radical peroxidation of plasma lipoproteins in healthy young persons from Naples and Bristol. *Eur. Heart J.*, *15*(7), 871-876.

Pesek, C. A. and Warthesen, J. J. (1990). Kinetic model for photoisomerization and concomitant photodegration of pcarotenes. *J. Agric. Food Chem.*, *38*, 1313-1315.

Qaisrani, T., Butt, M., Hussain, S. and Ibrahim, M. (2014). Characterization and utilization of psyllium husk for the preparation of dietetic cookies. *Int. J. Modern Agric.*, *3*(3), 81-91.

Raymundo, A., Fradinho, P. and Nunes, M. C. (2014). Effect of Psyllium fibre content on the textural and rheological characteristics of biscuit and biscuit dough. *Bioactive carbo. dietary fibre*, *3*(2), 96-105.

Rekha, M. N., Chauhan, A. S., Prabhasankar, P., Ramteke, R. S. and Rao, G. V. (2013). Influence of vegetable purees on quality attributes of pastas made from bread wheat (*T. aestivum*). *CyTA-J. Food*, *11*(2), 142-149.

Ribeiro, H. S., Ax, K. and Schubert, H. (2003). Stability of lycopene emulsions in food systems. *J. Food Sci.*, *68*, 2730–2734.

Sharma, S. K. and Maguer, M. L. (1996). Kinetics of lycopene degradation in tomato pulp solids under different processing and storage conditions. *Food Res. Int.*, *29*, 309-315.

Shukla, K. and Srivastava, S. (2011). Evaluation of finger millet incorporated noodles for nutritive value and glycemic index. *J. Fd. Sci. Technol.*, *6*, 105-113.

Singh, S. and Gaikwad, K. K. (2012). Studies on the development and storage stability of bitter gourd lemon function RTS beverage. *Int. J. Process. Postharv. Technol.*, *3*(2), 306-310.

Sudhindra, K. S. N., Sreenivas, K. N., Shankarappa, T. H. and Ravindra, V. J. (2012). Standardization of recipe for value added nutraceutical beverages of guava blended with *Aloe vera* and Roselle. *J. Environ Ecol.*, *30*(3), 995-1001.

Syed, M, Sabir, A. W., Chaudhary, F. M. and Bhatty, M. K. (1986). Antimicrobial activity of the essential oils of umbelliferae family, *Trachyspermum*, *Apium grevolens* oils. *Pak. J. Sci. Ind. Res.*, *29*, 189-192.

Vaghashiya, J. M. (2018). Studies on processing and value addition of Aloe vera. *Thesis Ph.D.*, Navsari Agricultural University, Navsari, Gujarat, India. 125 p.

Xianquan, S., Shi, J., Kakuda, Y. and Yueming, J. (2005). Stability of lycopene during food processing and storage. *J. Med. Food*, *8*(4), 413-422.

Yadav, D. N., Sharma, M., Chikara, N., Anand, T. and Bansal, S. (2014). Quality characteristics of vegetable-blended wheat-pearl millet composite pasta. *Agricl. Res.*, *3*(3), 263-270.

How to cite this article: Dev Raj, Maru Shveta M., J.M. Mayani and Gohil Mehul M. (2023). Standardization of Formulation for Preparation of Vegetable Enriched Pasta. *Biological Forum – An International Journal*, *15*(10): 1355-1365.