STUDIES ON EFFECTS OF GARDENCRESS SEED (Lepidium sativum L.) INCORPORATION ON THE QUALITY OF BLACK GRAM (Vigna mungo L.) SPICED PAPAD

Submitted By
TALPADE NITIN NIVRUTTI
B. Tech. (Food Technology)

DISSERTATION
Submitted to the
Marathwada Krishi Vidyapeeth, Parbhani In
Partial fulfillment of the requirements
For the degree of

MASTER OF TECHNOLOGY
IN
FOOD TECHNOLOGY

COLLEGE OF FOOD TECHNOLOGY
MARATHWADA KRISHI VIDYAPEETH
PARBHANI - 431 402 (M.S.) INDIA

2018
ACKNOWLEDGEMENT

A wave of elation sweeps me off my feet, joy exuberates my heart and a sense of achievement pervades my mind as I take another step forward my academic pursuit with the completion of this work and acknowledge all those who helped me. At first, my thanks to Almighty for blessing me with loving family and admirable teachers who inculcated in me the zeal to win and succeed in life.

I feel proud and privileged to express my deepest sense of gratitude to my honourable guide Dr. V.S. Pawar, Associate Professor, Department of Food Chemistry and Nutrition, College of Food Technology, M.K.V., Parbhani for her constant support, worthy guidance, valuable suggestions, encouragement and helping attitude throughout the course of present investigation without which it was not possible for me to execute my research investigation and degree.

I owe high esteemed respect to Dr. A. R. Sawate, Associate Dean and Principal, College of Food Technology, M.K.V., Parbhani for providing necessary facilities during the present investigation. I am indebted to Dr. B. Venkateswarlu, Vice Chancellor, V.N.M.K.V., Parbhani for providing facilities to conduct the present investigation.

I sincerely express my deep sense of gratitude and great indebtedness to the advisory committee members, Dr. Syed H. M., Dr. D.M. Shere and Dr. G. S. Pawar. Who have taken much effort and rendered worthy suggestions.

I wish to place on record my sincere thanks to, Prof. D.R. More, Prof. H.W. Deshpande, Dr. A.T. Taur, Dr. R. B. Kshirsagar, Dr. B. S. Agarkar, Dr. K. S Gadhe, Prof. Ghatage Prof. Sadavarte College of Food Technology. Thanks to all non-teaching staff of College of Food Technology, for their kind cooperation during completion of my PG education.
I would like to thank all the teachers and other staffs for their direct and indirect help during this study, especially Bhokare Madam, Rafik Mama, Ashok Dada, Gangatai.

Friendship is a pleasant experience most of all, special thanks to my friends Abu Sufiyan Farooqui, Rushikesh Mane, Rajan Kale, Aamer Hashmi, Moh. Nisar, Moh. Najeeb, Vaibhavi Uttarwar, Manjusha Katkade, Ratnmala Walekar and Shraddha. Specially thanks Ph.D and M. Tech. Scholar Manmath Sontakke sir, Rahul Salve sir, Kachhave ma'am, Govind Desai sir, Narendra Deshmukh sir, Suradakar sir, Sonkamble sir, Surendra sir, helped me directly or indirectly during the period of my college life.

My warm and special thank all School and Jr. Friends Sandeep Bhagwat, Rohit Suryawanshi, Pravin Jagtap who supported me all the way during my post-graduation. I owe to my beloved M. Tech. juniors Eknath Shinde, Shailesh Veer, Suwarana Patangare, Ganesh Gaikwad, Sugreev Shinde, Krushna Sawale.

Mere words are never sufficient to express my whole hearted sense of reverence to my respectful Father Mr. Nivrutti and Mother Mrs. Suman and my Younger Sisters Miss. Shilpa, and Miss. Kalyani and all well-wishers and all those who have been forgotten due to my shortcomings whose silent presence has always guided my efforts. I think words with me are insufficient to express the feelings of my heart to acknowledge them for their difficult job of educating me and keeping me in all comforts.

At the end, I owe my un-expressible gratitude to The God the only creator of the universe and source of all knowledge and wisdom, who blessed me with health, thoughts, talented teachers, helping friends and opportunity to complete this study.

PLACE : PARBHANI
DATE : / /2018

(TALPADE NITIN NIVRUTTI)
(Reg. No. 2016T13M)
# CONTENT

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1-7</td>
</tr>
<tr>
<td>2</td>
<td>REVIEW OF LITERATURE</td>
<td>8-31</td>
</tr>
<tr>
<td>3</td>
<td>MATERIAL AND METHODS</td>
<td>32-49</td>
</tr>
<tr>
<td>4</td>
<td>RESULTS AND DISCUSSION</td>
<td>50-75</td>
</tr>
<tr>
<td>5</td>
<td>SUMMARY AND CONCLUSION</td>
<td>76-81</td>
</tr>
<tr>
<td>6</td>
<td>LITERATURE CITED</td>
<td>I-VIII</td>
</tr>
<tr>
<td>7</td>
<td>APPENDIX – I</td>
<td></td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formulation for preparation of Gardencress powder papad</td>
<td>35</td>
</tr>
<tr>
<td>2</td>
<td>Physical properties of Black gram split and Gardencress seed</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>Nutritional composition of Black gram split and Gardencress seed</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>Antinutritional factors of Black gram split and Gardencress seed</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Colour characteristics of raw and roasted gardencress seed powder</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>Physical properties of papad incorporated with gardencress seed powder</td>
<td>57</td>
</tr>
<tr>
<td>7</td>
<td>Sensory evaluation of different formulation of toasted papad</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>Sensory evaluation of different formulation of fried papad</td>
<td>62</td>
</tr>
<tr>
<td>9</td>
<td>Influence of gardencress seed powder on textural properties of papad</td>
<td>64</td>
</tr>
<tr>
<td>10</td>
<td>Effect of gardencress seed powder addition on colour characteristics of papad</td>
<td>66</td>
</tr>
<tr>
<td>11</td>
<td>Proximate composition of papad prepared with addition of gardencress seed powder</td>
<td>68</td>
</tr>
<tr>
<td>12</td>
<td>Mineral composition of papad added with gardencress seed powder</td>
<td>70</td>
</tr>
<tr>
<td>13</td>
<td>Influence of packaging material and storage period on qualities of papad (at ambient temperature)</td>
<td>71</td>
</tr>
<tr>
<td>14</td>
<td>Microbial properties of papad</td>
<td>72</td>
</tr>
<tr>
<td>15</td>
<td>Energy Value of different formulation of papad</td>
<td>73</td>
</tr>
<tr>
<td>16</td>
<td>Cost of production of gardencress papad.</td>
<td>75</td>
</tr>
</tbody>
</table>
# LIST OF FLOW SHEETS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preparation of gardencress seed powder</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>Preparation of black gram flour</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Preparation of papad</td>
<td>37</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Title</th>
<th>In Between Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Representative graph of Texture Profile Analysis (TPA)</td>
<td>47-48</td>
</tr>
<tr>
<td>2</td>
<td>Diameter of papad before and after frying</td>
<td>57-58</td>
</tr>
<tr>
<td>3</td>
<td>Expansion ratio of papad</td>
<td>58-59</td>
</tr>
<tr>
<td>4</td>
<td>Sensory evaluation of toasted papad</td>
<td>60-61</td>
</tr>
<tr>
<td>5</td>
<td>Sensory evaluation of fried papad</td>
<td>62-63</td>
</tr>
<tr>
<td>6</td>
<td>Textural properties of papad</td>
<td>64-65</td>
</tr>
<tr>
<td>7</td>
<td>Textural properties of raw papad</td>
<td>65-66</td>
</tr>
<tr>
<td>8</td>
<td>Textural properties of fried papad</td>
<td>65-66</td>
</tr>
<tr>
<td>9</td>
<td>Textural properties of toasted papad</td>
<td>65-66</td>
</tr>
<tr>
<td>10</td>
<td>Colour characteristics of papad</td>
<td>66-67</td>
</tr>
<tr>
<td>11</td>
<td>Chemical composition of gardencress papad</td>
<td>68-69</td>
</tr>
<tr>
<td>12</td>
<td>Energy value of papad</td>
<td>73-74</td>
</tr>
</tbody>
</table>
# LIST OF PLATES

<table>
<thead>
<tr>
<th>Plate No.</th>
<th>Title</th>
<th>In Between Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Raw gardencress seed</td>
<td>35-36</td>
</tr>
<tr>
<td>2.</td>
<td>Roasted gardencress seed</td>
<td>35-36</td>
</tr>
<tr>
<td>3.</td>
<td>Roasted gardencress seed powder</td>
<td>35-36</td>
</tr>
<tr>
<td>4.</td>
<td>Black gram flour</td>
<td>35-36</td>
</tr>
<tr>
<td>5.</td>
<td>Texturometer (Stable Micro System TAXT2 plus)</td>
<td>64-65</td>
</tr>
<tr>
<td>6.</td>
<td>Colorometer (ColorFlex EZ)</td>
<td>65-66</td>
</tr>
<tr>
<td>7.</td>
<td>Control Raw (T0)</td>
<td>68-69</td>
</tr>
<tr>
<td>8.</td>
<td>Control Toasted (T0)</td>
<td>68-69</td>
</tr>
<tr>
<td>9.</td>
<td>Control Fried (T0)</td>
<td>68-69</td>
</tr>
<tr>
<td>10.</td>
<td>Treatment Raw (T1)</td>
<td>68-69</td>
</tr>
<tr>
<td>11.</td>
<td>Treatment Toasted (T1)</td>
<td>68-69</td>
</tr>
<tr>
<td>12.</td>
<td>Treatment fried (T1)</td>
<td>68-69</td>
</tr>
<tr>
<td>13.</td>
<td>Treatment Raw (T2)</td>
<td>68-69</td>
</tr>
<tr>
<td>14.</td>
<td>Treatment Toasted (T2)</td>
<td>68-69</td>
</tr>
<tr>
<td>15.</td>
<td>Treatment fried (T2)</td>
<td>68-69</td>
</tr>
<tr>
<td>16.</td>
<td>Treatment Raw (T3)</td>
<td>68-69</td>
</tr>
<tr>
<td>17.</td>
<td>Treatment Toasted (T3)</td>
<td>68-69</td>
</tr>
<tr>
<td>18.</td>
<td>Treatment fried (T3)</td>
<td>68-69</td>
</tr>
<tr>
<td>19.</td>
<td>Sample (T1) Storage in HDPE</td>
<td>71-72</td>
</tr>
<tr>
<td>20.</td>
<td>Sample (T1) Storage in Steel Box</td>
<td>71-72</td>
</tr>
<tr>
<td>21.</td>
<td>Sample (T1) Storage in Aluminium Foil Pouches</td>
<td>71-72</td>
</tr>
<tr>
<td>22.</td>
<td>Total Plate Count</td>
<td>72-73</td>
</tr>
<tr>
<td>23.</td>
<td>Yeast and Mold</td>
<td>72-73</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Elaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>@</td>
<td>At the rate</td>
</tr>
<tr>
<td>%</td>
<td>Per cent</td>
</tr>
<tr>
<td>°C</td>
<td>Degree Celsius</td>
</tr>
<tr>
<td>CD</td>
<td>Critical Difference</td>
</tr>
<tr>
<td>cfu</td>
<td>Colony forming unit</td>
</tr>
<tr>
<td>cm</td>
<td>Centimeter</td>
</tr>
<tr>
<td><em>et al.</em>,</td>
<td><em>et alibi</em> (and associates)</td>
</tr>
<tr>
<td>etc.</td>
<td>Etcetera</td>
</tr>
<tr>
<td>g</td>
<td>Gram</td>
</tr>
<tr>
<td>Hrs.</td>
<td>Hour</td>
</tr>
<tr>
<td>i.e.</td>
<td>That is</td>
</tr>
<tr>
<td>kg</td>
<td>Kilogram</td>
</tr>
<tr>
<td>mg</td>
<td>Milligram</td>
</tr>
<tr>
<td>ml</td>
<td>Milliliter</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>No.</td>
<td>Number</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error</td>
</tr>
<tr>
<td><em>viz.</em></td>
<td><em>Videelict</em> (namely)</td>
</tr>
<tr>
<td>Kcal</td>
<td>Kilocalorie</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
</tr>
<tr>
<td>GCSP</td>
<td>Gardencress seed powder</td>
</tr>
<tr>
<td>BGF</td>
<td>Black gram flour</td>
</tr>
<tr>
<td>Θ</td>
<td>Thita</td>
</tr>
<tr>
<td>ρ</td>
<td>Rho</td>
</tr>
<tr>
<td>M eq.</td>
<td>Milli equivalent</td>
</tr>
</tbody>
</table>
Dr. V. S. Pawar

Associate Professor,
Dept. of Food Chemistry and Nutrition,
College of Food Technology,
Marathwada Krishi Vidyapeeth,
Parbhani- 431 402 (M.S.) India.

CERTIFICATE - I

This is to certify that Mr. Talpade Nitin Nivrutti has satisfactorily prosecuted his course credits and research work for a period not less than four semesters and that the dissertation entitled “Studies on effects of gardencress seed (Lepidium sativum L.) incorporation on the quality of black gram (Vigna mungo L.) spiced papad” submitted by him is the results of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for the award of a degree of any university.

PLACE: PARBHANI.  
DATE:  /  /2018  

DR. V. S. PAWAR  
(Research Guide)
CERTIFICATE -II

This is to certify that the dissertation entitled “Studies on effects of gardencress seed (Lepidium sativum L.) Incorporation on the quality of black gram (Vigna mungo L.) Spiced papad” submitted by Mr. Talpade Nitin Nivrutti to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirements for the degree of MASTER OF TECHNOLOGY (FOOD TECHNOLOGY) has been approved by the student's advisory committee after Viva-voce examination in collaboration with the external examiner.

External Examiner

Dr. V. S. PAWAR
(Research Guide and chairman)

Members of Advisory Committee

Dr. H. M. Syed
Professor (CAS) and Head,
Dept. of Food Chemistry and Nutrition
College of Food Technology,
V. N. M. K. V. Parbhani

Dr. D. M. Shere
Professor (CAS), and Head
Dept. of Food Science and Technology
College of Food Technology,
V. N. M. K. V. Parbhani

Dr. G. S. Pawar
Assistance Professor,
Dept. of Seed Technology,
V.N. M. K. V. Parbhani

Associate Dean and Principal
College of Food Technology,
VNMKV, Parbhani – 431 402.
CHAPTER I

INTRODUCTION

_Papad_ is a delicious traditional Indian snack food used as an accompaniment with meals and snacks and croutons in soups. In recent years, it has gained recognition as India's unique contribution to international menu. Papads have crunchy wafer-like taste and are normally consumed after roasting or frying. The papad industry in India is predominantly a cottage industry and is mainly started for women empowerment and social welfare. Increased mass production of papad for domestic consumption and export has necessitated standardization and quality evaluation of the finished product. The commercial production of papads is more than 55,000 tonnes of which 12,000 tonnes are being exported. Various small scale and national brands are into papad manufacturing in India (Awalgaonkar <i>et. al.</i>, 2015).

In India, black gram papad is a commercial product and the variations in quality (Senthil <i>et. al.</i>, 2006). _Papad_ is one of the popular snack items and it is very tasty so, used in every Indian diet since older days. It is consumed either as such often frying or roasting or as adjunct along with vegetable soups and curries. It is usually made from a blend of cereal flour, edible starch and pulse flour with common salt, spices, edible oil, and mucilaginous additives (Agrawal <i>et. al.</i>, 2016).

_Papad_ is prepared from cereals, legumes and combinations thereof with addition of spices, salts and alkaline additives. Papads prepared from rice, black gram, green gram, sago, potato, and sorghum are quite popular all over world. According to consumer preferences, papads from black gram split pulse (94.4 percent), rice (63.8 percent) and green gram splits (33.3 percent) are the most preferred (Kamat <i>et. al.</i>, 2009).
Pulses are one of the second most important segments of Indian Agriculture after cereals as they rich in protein and play vital role in human diet. Pulses improve soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping systems. It meets up to 80% of its nitrogen requirement from symbiotic nitrogen fixation from air. In India, production of pulses is around 19.3 million tonnes with a very low average productivity of 764 kg ha\(^{-1}\). Pulses are least preferred by farmers because of high risk and less remunerative than cereals; consequently, the production of the pulses is sufficiently low.

Pulses are known to form the important of protein and other dietary constituents in Indian diet. Black gram (\textit{Vigna mungo} L.) has occupied an important place in human nutrition as rich source of protein in the diet of consumers of India and Western diet. Proteins of black gram are more easily digestible and are almost as good as meat and very good source of phosphoric acid and vitamins. It also consists of satisfactory amount of sulphur containing amino acids (FAO/WHO, 1973). In India black gram consumed in the form of dhal. It is used as source for microorganisms in fermented foods. It is also preferred in the preparation of many fermented foods like idli, dosa, wada etc. Although it is good source of protein, presence of Antinutritional factors is one of the main drawbacks limiting the nutritional and food qualities of legumes (Liener, 1994). Black gram contains some Antinutritional factor such as protease inhibitors, amylase inhibitors, polyphenols, phytic acid, tannic acid etc (Singh and Jambunathan, 1982).

Black gram (\textit{Vigna mungo} L.) belongs to family \textit{Fabaceae} sub family \textit{papilionaceae}, is being grown as one of the principle pulse crop. In India black gram is a grown in 3.11 Mha area with total production of 1.90MT and average productivity is 642 kg/ha (Anonymous, 2013). The estimated production of black gram for the year 2016-17 is 183 MT in Maharashtra (Economic Survey of
Maharashtra, 2018). Black gram in India is a highly valued pulse which contributes a wonderful taste to South India dish like ‘Vada’ and ‘Dal makhni’ of North India. It contains on average 10.9% moisture, 24% protein, 1.4% fat, 0.9% fibre and 59.6% carbohydrate as main component (Sharon et. al., 2015). This crop is extensively grown in the states of Maharashtra (23.36%), Andhra Pradesh (18.50%), Uttar Pradesh (12.29%), Madhya Pradesh (11.86%), Tamil Nadu (8.64%) and Rajasthan (4.29%). It can be grown on all type of soils ranging from sandy loam to heavy clay except alkaline and saline soils. However, it does well on heavier soils such as black cotton soils which retain higher moisture for longer time.

Black grams are widely considered as an excellent source of high quality protein with good digestibility and also contain water soluble vitamins and minerals of dietary significance. The factors attributed for low yields of pulses in India as compared to the world productivity are non-availability of quality seeds of improved and short duration varieties, growing of pulses under marginal and less fertile soil with low inputs and without pest and disease management, growing of pulses under moisture stress, unscientific post harvest practices and storage under unfavourable conditions. Hence, there is a scope for improving the production potential of this crop by use of organic manures, inorganic manures and biofertilizers (Vadgave, 2010).

Garden cress (Lepidium sativum Linn.) is an annual herbaceous edible plant and a member of the Cruciferae (Brassicaceae) family that is botanically related to mustard and watercress. It is commonly known as “Aliv” in Marathi, “Halim” in Hindi “Haliv”, “ land cress”, Asali”, “Chandrasur” in India. Garden cress seed is categorized under nuts and oil seeds by ICMR. It is cultivated in India, North America and parts of Europe and used as culinary vegetable all over Asia (Yareshimi and Hiremath, 2017).
Gardencress is also known as pepper cress, pepper grass or pepperwort. Cress tastes somewhat like radishes. There are both smooth and curled leaf varieties. Gardencress is a reseeding annual plant that drops its seed back into the soil and lays dormant until the following year. Cress can be grown in full sun to partial shade. Its seeds are light-germinating, usually sprouting within 2 to 4 days. It has long leaves at the bottom of the stem and small, bright-green, feathery leaves on opposite sides at the top.

It is a polymorphous species originated primarily in the highland region of Ethiopia and Eritrea. Garden cress (GC) or pepper cress is a fast-growing edible plant. Seeds, leaves and roots of Garden Cress are of economic importance; however, the crop is mainly cultivated for seeds. It is an important medicinal crop in India (Tiwari and Kulmi, 2004). Cress is widely cultivated in temperate climates throughout the world for various culinary and medicinal uses. This plant is a native of Mediterranean region. Now, it is being cultivated throughout India very likely indigenous in West Asia. In India, it is mainly cultivated in U.P., Rajasthan, Gujarat, Maharashtra, and Madhya Pradesh (Gokavi et. al., 2004).

It is an erect branched, glabrous herb with 60 cm height. Leaves are entire or pinnately dissected, variously lobed often with linear segments; up to 6-5 cm long and lobes are 0.7-1.2 to 0.3-0.6 cm sizes, upper leaves usually entire, and 2-3 cm long, oblanceolate, sessile. Racemes are 7 to 15 cm long axillary and terminal; flowers are white or pale pink; pedicels are 3 to 5 mm long. Pods are obovate or broadly elliptical, roundate, emarginated slightly but thickly winged above. Garden cresses have orange, white, or light-pink colored flowers that are very decorative and also produce fruits which, when immature, are very much like capers.

Gardencress is suitable for cultivation in very moist soil or even under water and thrives in a slightly alkaline environment. Cress can actually be grown
without any soil, by using moist paper towels or wet cotton balls. Cress is an important leafy green vegetable, most typically used as a garnish or as salad greens. Both the leaves and stems of young cress sprouts can be eaten.

Gardencress is one such food stuff that abounds not only in nutrients but also in health enhancing phytochemicals. This has been the reason why tradition, folklore and indigenous medicine, all advocated garden cress for finding succor from one or the other ailment (Agarwal and Sharma, 2013).

Nutritionally the seeds comprise (25%) of protein, (33 to 54%) of carbohydrates, (14 to 24%) of lipids, and (8%) of crude fiber. The major fatty acid present in garden cress is alpha-linolenic acid (34.0%) and also contains monounsaturated fatty acids (37.6%), polyunsaturated fatty acids (46.8%) and antioxidants such as tocopherols and carotenoids. Seeds are also excellent source of minerals like zinc, phosphorous and calcium. Garden cress seeds are claimed to possess various pharmachemical properties like galactogue and antioxidants and has a tremendous potential to be developed as a functional food. Also, it’s cheaper availability and high nutrient density makes it suitable to the weaker sections of society to include in their diets (Kaur and Sharma, 2016).

The seeds contain alkaloids (Sinapine, Choline ester of Sinapic acid) (0.19%), Glucoside (glucotropaeolin) (5%), Mucilage matter (0.8%) Cellulose (18.3%), Yellowish oil (25.3 g) (Palmitic, stearic, Arachidonic, Oleic and Linoleic acid). Cress seeds also contain (25.5%) yellowish oil with Palmitic acid (1.27%), Stearic acid (6.01%), Arachidonic acid (1.54%), Behenic (1.73%), Lingoceric (0.20%), Oleic (61.25%), Linoleic (28%). It is the highest iron containing plant source ever known with better bioavailability (Sarkar et. al., 2014). The most potent isothiocyanates are benzyl isothiocyanate (BITC) which is present in ample quantity in garden cress. Isothiocyanates are most important biochemical agents
from the human health point of view as they are the major inducers of carcinogen-detoxifying enzyme (Singh et al., 2015).

Its bran has high water holding capacity and dietary fibre (74.3%). The swelling property of husk is mainly because of mucilaginous matter present in it. The mucilage consists of a mixture of cellulose (18.3%) and uronic acid containing polysaccharide (Sharma and Agarwal, 2011). Garden cress seed have been used in traditional medicine since ancient times in India. It is galactogogue, bitter, thermogenic, depurative, rubefacient, aphrodisiac, ophthalmic, antiscorbutic, antihistaminic, diurectic and act as tonic. Various diseases like asthma, coughs with expectoration, diarrhoea, dysentery, poultices for sprains, leprosy, skin disease, splenomegaly, dyspepsia, lumbago, leucorrhoea, scurvy and seminal weakness can be treated using garden cress seed. It is supplemented in the diet of lactating women to increase the milk secretion during post-natal period and also recommended for the treatment of diarrhoea and dysentery. Seeds of garden cress are prescribed by Ayurvedic practitioners for the treatment of bronchial asthmatic patients and rapid bone fracture healing (Singh et al., 2015).

The edible whole seeds are known to have health promoting properties hence it was assumed that these seeds can serve as raw material for functional foods. Seeds can serve as raw material for functional foods. Food products can be developed using garden cress seed with increased amount of protein, fat, calcium, iron and phosphorus. The developed food products using garden cress seeds could be beneficial for masses as nourishing as well as therapeutic agents due the presence of various properties like hypoglycaemic, hypotensive, fracture healing, and anticancerous etc. for prevention and management of this diseases (Singh et al., 2015).
In the view of the importance with of Gardencress based product like papad with respect to its texture profile, chemical composition and sensory quality, the present investigation has been undertaken with following objectives.

OBJECTIVES:

1. To study the physical and chemical properties of Gardencress seed (*Lepidium sativum* L.) and Black gram Split (*Vigna mungo* L.).
2. To standardize the recipe for preparation of *papad*.
3. To study the organoleptic evaluation of *papad*.
4. To assess the physico-chemical properties of *papad*.
5. To study the storage of papad with different packaging material.
6. To study the microbial quality of selected *papad*.
7. To evaluate energy value and cost economics of *papad*. 
CHAPTER II

REVIEW OF LITERATURE:

This section is intended to review and summarize the published work on various aspects of Indian traditional foods with particular emphasis on "Papad making" and utilization of gardencress seed powder in papad.

Rapid advances in science and technology, increasing health care costs, an aging population and rising interest in attaining wellness through diet are among the factors fuelling interest in nutraceuticals. Credible scientific research indicates many potential health benefits from food components. Many traditional plants products have been shown to possess disease combating potential against modern age, life style diseases like obesity, diabetes, cardiovascular diseases, etc.

In the present research plan, efforts have been made in this direction; accordingly Gardencress seeds (Lepidium sativum L.) are evaluated for their nutraceutical and functional properties such as physico-chemical properties, recipe standardization, storage with different packaging materials and microbial study. The literature pertaining to different aspects of the present study has been reviewed under the following captions.

OBJECTIVE:

2.1 To study the physico-chemical properties of Gardencress seed (Lepidium sativum L.) and Black gram split (Vigna mungo L.).

2.2 To standardize the recipe for preparation of papad.

2.3 To study the sensory evaluation of papad prepared with incorporation of gardencress seed.

2.4 To assess the physico-chemical properties of papad.

2.5 To study the storage with different packaging material.

2.6 To study the microbial quality of papad.

8
2.1. Physico-chemical properties of Gardencress seed (*Lepidium sativum* L.) and black gram (*Vigna mungo* L.)

### 2.1.1. Gardencress Seed

Gopalan *et al.*, (2004) indicated the nutritive value of Garden cress seeds as Energy 454 (Kcal.), Moisture 3 (gm), protein 25 (gm), Fat 24 (gm), Mineral 6 (gm), Fiber 8 (gm), Carbohydrate 33 (gm), Calcium 377 (mg), Phosphorous 723 (mg), Iron 100 (mg), magnesium 430 (mg) and other nutrients such as thiamine 0.59 (mg), riboflavin 0.61 (mg), niacin 14.3 (mg).

Gokavi *et al.*, (2004) have analyzed Chemical composition of Gardencress seeds with high nutritional value can be exploited as a functional food ingredient and as nutraceutical food ingredient in dietary fiber formulation. Three fractions namely whole meal (WM), endosperm and bran were analyzed for chemical composition. The yield of the endosperm and bran fraction was (72) and (28 %), respectively. The whole meal, endosperm and bran had (22.5), (27.7) and (12.6 %) protein, (27.5), (33.1) and (6 %) fat, (30), (13.6) and (75 %) Dietary fiber (DF) and (1193.00), (945.15) and (1934.57 mg %) potassium respectively. The most abundant amino acid was glutamic acid (19.3 %) and the essential amino acid, leucine was the highest and methionine the lowest.

Gunstone (2004) examined the phytosterol content of garden cress and detect the primary phytosterols in cress oil included sitosterol (5.82 mg/g), campesterol (3.95 mg/g), and avenasterol (3.44 mg/g), with cholesterol (0.50 mg/g), stigmasterol (0.30 mg/g), dihydrolanosterol (0.25 mg/g), and amyrin (0.16 mg/g) comprising the remaining steroidal constituents. As is the case with most vegetable oils, sitosterol was the major phytosterol found in cress oil. The combined phytosterol content of cress oil was (14.41 mg/g), which was in excess of the typical range of (1–5 mg/g) for most vegetable oils.
Dale (2006) noted that the *Cruciferous* vegetables are rich in vitamins, minerals, and antioxidants, which undoubtedly contribute to their healthful effects. However, scientists have identified other bioactive compounds in these vegetables that are specifically responsible for their cancer-preventive effects. These compounds, which are called glucosinolates, are transformed to indole-3-carbinol (I3C) and diindolylmethane (DIM) in the body.

Moreno *et. al.*, (2006) reported that the bioavailability, transport and metabolism of glucosinolates after consumption of brassica vegetables as food are a prerequisite for understanding the mechanisms of their protective effects in humans. “Bioavailable” nutrient or Bio-nutrient (e.g. Bio-iron) corresponds to the fraction of ingested nutrient used to meet functional demand in target tissues. Sweetness, crispness and intensity (intense bitter, pungent and green/grassy notes) of broccoli flavour are important attributes for broccoli acceptability, and glucosinolate content affects these sensory profiles, ultimately affecting consumer acceptance.

Paranjape and Metha (2006) investigated the morphology and clinical of garden cress seeds which shown seed were brownish red in color and oval in shape. Morphologically, garden cress seeds resemble that of an oil seed with the dicotyledonous endosperm accounting to (80-85%) of the seed matter, the seed coat account for (12-17%) and the embryo for (2-3%) of the seeds.

Bryan *et. al.*, (2009) investigated the oil of garden cress and found that the primary Fatty Acid in cress oil were oleic (C18:1; 30.6 wt. %) and linolenic (C18:3; 29.3 wt. %) acids, with gondoic (C20:1; 11.1 wt. %), palmitic (C16:0; 9.4 wt. %) and linoleic (C18:2; 7.6 wt. %) acids also detected in significant quantities Erucic (C22:1; 3.0 wt. %), stearic (C18:0; 2.8 wt. %), and arachidic (C20:0; 2.3 wt. %) acids were among the minor FA found in cress oil. These results are in close agreement with previous studies the average Molecular Weight of cress oil
calculated from the Fatty Acid profile was 891.94 g/mol. The oil content of dried cress seeds was (22.7 wt. %). Cress oil contained high amounts of tocopherols. The unusually high percentage of tocopherol may make cress oil a potentially useful industrial source of this natural antioxidant.

Bastihalli et. al., (2010) examined the physicochemical properties of garden cress oil and concluded that Linolenic acid (34%) was the major fatty acid in garden cress oil followed by oleic (22%), linoleic(11.8%), ecosanoic (12%), palmitic (10.1%), erucic (4.4%), arachidic (3.4%),and stearic acids (2.9%). Oleic acid (39.9%) and α- linolenic acid (42.1%) were predominant fatty acids at the sn-2 position. The total tocopherol and carotenoid content of garden cress oil was (327:42) and (1.0 µmol/100 g) oil respectively.

Gaafar et. al., (2013) analyzed the chemical and mineral composition of garden cress seed and found moisture (5.12 ± 0.96), Crude protein (Nx 6.25) (24.29 ± 1.65), crude lipids (27.85 ± 1.73), crude fiber (7.79 ± 0.85), ash (4.26 ± 0.91), total carbohydrates (35.81 ± 2.37), calcium (243.12 ± 6.51), phosphorus (427.36 ± 9.16), magnesium (239.47 ± 4.19), potassium (975.16 ± 10.66), iron (8.34 ± 1.02), zinc (1.19 ± 0.13), copper (1.25 ± 0.18), sodium (19.65 ± 1.52), respectively.

Behrouzian et. al., (2014) concluded that the physical and chemical properties of garden cress seed. Seed were brownish red and oval shaped with mean dimensions of (2.692±0.102 mm) in length (1.243 ± 0.066 mm) in width and (0.947± 0.060 mm) in thickness. Its bulk density is (742.60 ± 1.52 kg/m3) and 100 seeds weighs about (0.196 ± 0.008 g). Similarly, chemical properties of soaked and powder cress seed showed moisture content (7.17%), ash (11.5%), protein (2.45%), fat (1.85%), calcium (0.17%), potassium (0.062),sodium (0.039%), magnesium (0.0076%) respectively.
Doke and Guha (2014) explored the physicochemical and mineral composition of gardencress seed and observed that gardencress seed were small, oval-shaped, pointed and triangular at one end, smooth, about (3 to 4 mm) long, (1 to 2 mm) wide, reddish brown in color. A furrow present on both surfaces extending up to two thirds downward, a slight wing like extension present on both the edges of seed. On soaking in water seed coat swells and gets covered with transparent, colorless, mucilage with mucilaginous taste. The seed length and width are (298 ± 3.2µm) and (100 ± 1.9 µm) respectively. Whereas, seed shows moisture content (4.14 ± 0.05), protein (22.47 ± 0.78), carbohydrates (34.24 ± 0.92), crude fiber (7.01 ± 0.08), ash (4.65 ± 0.09), energy (kcal) (474 ± 1.06), insoluble dietary fiber (28.49± 0.38), soluble dietary fiber (1.51 ± 0.09), total dietary fiber (30 ± 0.47), potassium (1193.95 ± 10.51), phosphorous (514.59 ± 10.67), magnesium (315.25 ± 3.6), calcium (296.60 ± 1.04), sulphur (293.02 ± 14.27), sodium (24.64 ± 0.02), iron (7.62 ± 0.0), copper (5.53 ± 0.0), zinc (5.05 ± 0.07), aluminium (2.82 ± 0.13), manganese (2.57 ± 0.04), boron (1.41 ± 0.03), molybdenum (0.43 ± 0.08).

Kilor and Brahme (2014) reported that seeds are small, oval- shaped about (2 to 3 mm) long and (1 to 1.5 mm) wide with reddish brown in color. Seeds when soaked in water swells and get covered with transparent, colorless mucilage.

Sarkar et. al., (2014) measured the physico-chemical, nutritional and medicinal properties of gardencress seeds are small oval shaped, pointed and triangular at one end, smooth, about (2 to 3 mm) long, (1 to 1.5 mm) wide, slightly broader at base and notched at apex, dorsiventrally bulging, a furrow present on both surfaces extending up to two thirds downward, a slight wing like extension present on both the edges of seed, when mixed with water the seeds become swollen and slippery by absorbing water and after boiling they form a gel like substance which has strong adhesive properties. Nutritive value of the seeds show: protein (25.5 g %), fat (24.5 g %), carbohydrate (33.0 g %), calcium
(377 mg %), phosphorous (723 mg %), iron (100 mg %), fibre (7.6 g %), carotene (27 mg %), thiamine (0.59 mg %), riboflavin (0.61 mg %), niacin (14.3 mg %). The seeds contain alkaloids (Sinapine, Choline ester of Sinapic acid) – (0.19 %), Glucoside (glucotropaeolin) – (5 %), Mucilage matter – (0.8 %), Cellulose – (18.3 %), Yellowish oil – (25.3 g) (Palmitic, stearic, Arachidonic, Oleic and Linoleic acid). (25.5 %) yellowish oil with Palmitic acid–(1.27 %), Stearic acid–(6.01 %), Arachidonic acid–(1.54 %), Behenic –(1.73 %), Lingoceric–(0.20 %), Oleic–(61.25 %) Linoleic–(28 %). Garden cress seeds mainly contain alkaloids such as lepidine, glucotropaeolin, N, N’-dibenzyl urea, N, N’- dibenzylthiourea, sinapic acid and Sinapin i.e. choline ester of sinapic acid.

Kaur and Sharma (2016) accessed the nutritional quality of the seed comprise (25 %) protein, (33-54 %) carbohydrates, (14–24 %) lipids, and (8 %) crude fiber. The major fatty acid present in garden cress is alpha-linolenic acid (34.0 %) and also contains monounsaturated fatty acids (37.6 %), polyunsaturated fatty acids (46.8 %).

Yareshimi and Hiremath (2017) evaluated nutritional composition of garden cress seeds results revealed that 100 g of seeds contain (4.24 g) moisture, (26.32 g) protein, (27.80 g) fat, (7.05 g) crude fibre, (29.97 g) carbohydrate and (475 Kcal) energy. Minerals such as calcium, phosphorus, iron, zinc, copper and manganese were found to be (253.46, 418.35, 6.48, 2.37, 2.31 and 1.52 mg) respectively. Vitamins viz., β-carotene, vitamin C and total tocopherol were (236.00 µg and 16.34 mg and 98.54 mg), respectively.

2.1.2. BLACK GRAM

Choon et. al., (2010) discussed the morphological and chemical characteristics of black gram sprouts (Vigna mungo), grown in a hermetically sealed chamber, was conducted using four seeding densities (50, 75, 100, and 125 g seeds L1). For this purpose, the selected presoaked seeds were put into a pot and
placed in the chamber. The seeds were allowed to sprout for four days and watering was done every three hours for 20 minutes. Sprouts produced with lower seeding density (50 and 75 g seeds L\(^{-1}\)) were long and etiolated with long roots and higher sprout weight. In higher seeding density (100 and 125 g seeds L\(^{-1}\)), on the contrary, sprout length was shorter with short roots and lower sprout weight, and the ratio between hypocotyl and root length was 1:1. Meanwhile, there were no significant differences in hypocotyl diameter of sprouts produced. Sprouts produced at a lower seeding density had (2.7\%) lower soluble solids concentration, but they had (18\%) higher contents of ascorbic acid as compared to the ones produced in higher seeding density. Thus, seeding density and watering duration during sprouting in a hermetically sealed chamber need to be determined for sustainable sprout production, as well as to produce safe sprouts as demanded by consumers.

Kavitha et. al., (2013) analyzed the physico chemical, functional, pasting properties, and nutritional composition of selected black gram varieties. (viz., VBN 3, VBN 4, VBN 5, VBN 6, ADT 3, T9, MV, TMV, VBg 010 025, VBg 010 024, VB g 09 005 and CO 6). Thousand grain weight of the selected black gram varieties was recorded to be (33.20 to 40.45 g), seed volume (38.66 to 40.2 ml), seed colour ranged as black, dull black and black and dull black, bulk density (0.06 to 1.07 g/ml), water absorption index (151.00 to 155.10 g/100 g ), water solubility index (13.0 to 15.6 g %), water absorption (36.6 to 56.6 ml/100 g) and oil absorption (40.1 to 66.2 ml/100 g). The moisture values were in the range of (9.6 to 11.6 g/100g), ash (6.1 to 6.7 g/100g), protein (25.5 to 28.5 g/100g), fat (4.4 to 5.6 g/100g), starch (51.3 to 47.7 g/100g), calcium (106.66 to 134.00 mg/100g), iron (3.0 to 4.4 mg/100g) and phosphorus (376.00 to 416 mg/100 g),respectively.

Theertha et. al., (2014) evaluated the effect of moisture content on some physical and gravimetric properties of black gram. Four levels of moisture content ranging from (10.23 to 19.73 %) dry basis were used. The average length, width,
thickness, geometric mean diameter, thousand seed mass and angle of repose were increased as the moisture content increased from (10.23 to 19.73 %) dry basis. As the moisture content increased from (10.23 to 19.73 %) dry basis, the bulk density was found to decrease from (692.30 to 661.50 kg m$^{-3}$), whereas true density increase from (1012.34 to 1315.03 kg m$^{-3}$), while the porosity was found to increase from (31.58 to 49.67 %). The static co-efficient of friction of black gram increased against various surfaces such as, plywood, cardboard, fibre board, glass and mild steel sheet, as the moisture content increased from (10.23 to 19.73 %) dry basis.

Sharon et. al., (2015) evaluated some moisture-dependent physical properties of Black gram namely, grain dimensions, thousand grain mass, surface area, sphericity, bulk density, true density, porosity and angle of repose. As the moisture content increased from (8.69 % to 21.95 %) dry basis, the three axial dimensions of the black gram increased and the arithmetic and geometric mean diameter ranged from (3.73 ± 0.14 to 4.27 ± 0.14 mm and 3.79 ± 0.13 to 4.32 ± 0.13 mm) respectively. The hundred grain mass of Black gram were (42.52 ± 1.03 and 48.18 ± 0.45 kg). The sphericity values of Black gram increased from (79.69 % to 82.82 %). The bulk and true densities values for Black gram decreased with increase in moisture content. The porosity and angle of repose of Black gram increased from (38.06 % to 42.60 % and 28.4° to 32.2°) respectively with increase in moisture content from (8.69 % to 21.95 %) dry basis.

Kamboj and Nanda (2017) analyzed the proximate composition, nutritional profile and health benefits of different legumes. The chemical composition of Black gram (Phaseolus mungo Roxb.) revealed that moisture content (10.9 g), protein (24.0 g), fat (1.4 g), minerals (3.2 g), crude fiber (0.9 g), carbohydrates (59.6 g), energy (347 kcal), calcium (154 mg), phosphorous (385 mg) and iron (3.8 mg), respectively. Whereas, vitamin content of black gram were reported carotene (38 ig), thiamine (0.42 mg), riboflavin (0.20 mg), niacin (2.0 mg), free
folic acid (24.0 ig), total folic acid (132.0 ig), vitamin C (0 mg) and choline (206 mg), respectively.

2.2. Standardize the recipe for preparation of papad

Garg and Dahiya (2003) prepared papads from wheat and legume blends and analyzed them for organoleptic acceptability, nutritional quality and keeping quality. Good quality wheat (Triticum spp.) and legumes namely Mungbean (Vigna radiata), chickpea (Cicer arietinum), and field pea (Pisum sativum) were taken. Cleaned wheat and legumes were milled in a hammer mill into flour of 80 mesh. Black gram flour was added to Mung gram flour in a ratio of 2:3 and was kept as control. Blends of control flour with sieved wheat flour and other legume flours were prepared in the weight ratio of (100:0, 90:10, 80:20 and 70:30) and were used for preparing papads using the standardized recipe. Preparation of dough with different proportion of mung flour (control)-600g, wheat flour, Mung flour+ wheat flour at (10, 20, 30%) level, Mung flour+ chickpea flour at (10, 20, 30%) level. Mung flour+ pea flour at (10, 20, 30%) level and the other ingredients used in all papads were black gram dhal flour (400 g), black pepper (50 g), sodium bicarbonate (55 g), cumin seeds (25 g), salt (70 g), mustard oil (20 ml) and lukewarm water (300 ml). All the dry ingredients were mixed to above each flour and a firm but pliable dough was kneaded with lukewarm water using mustard oil. Dough was kept for half an hour and dough was divided into small balls of 25 to 30 g and rolled on a circular plate having a smooth surface with a wooden pin (roller) to give a disc of about 0.6 to 0.8-mm thickness and 15 to 20-cm diameter. Papads were dried in the sun to a desired moisture level and packed in polythene bags till roasted.

Rahman and Uddin (2008) developed papad from legume flour and analyzed them for chemical analysis and shelf life. Papads were prepared from Mungbean, Grasspea (Khasari dal), Black gram (Mashkolai dal) incorporating soya flour. All the ingredients were collected from the local market. Five different
types of papads were prepared using (0%, 5%, 10%, 15%, 20%) soya flour with pulses and other ingredients. The preparation involves gelatinisation of the soya flour with minimum quantity of water. The soya flour was mixed with requisite quantity of other ingredients. All the ingredients were mixed in a mixture to make a dough. After 30 min. resting the dough was divided into balls of about 2 to 3 cm dia. weighing 5 to 6 gm. These were rolled into thin circular discs of about 1 mm thickness using rolling pin. The papads were dried in drier at 50°C. The dried papads at this stage contained about 14 to 15% of moisture. The dried papads were then packed in polythene bags. These dried papads were consumed by deep frying in oil. The final products usually undergo 2 to 3 times expansion on frying.

Veena et.al., (2012) studied the effects of incorporation of soy flour on the quality of papad the different variation of soybean flour was blended with black gram flour in the ratio of 20:80, 30:70, 40:60, 50:50 and 0:100 (control). Different flours like black gram flour, soy flour, sago flour and rice flours were mixed according to above mentioned ratios. This blended cereal and pulse flours was pored to boiling water then stirred well by adding spices. Later divide the dough into small balls (12g each). This though was placed in oil smeared polyethylene sheets. By applying pressure on roller thin papad sheets were prepared. Papad sheet was cut in to required size and shape. Place these cut sheets (papads) in hot air oven at 50°C for 5Hr. Profile of sensory characteristics (Organoleptic evaluation) was performed by a panel of 15 experts at every month for a period of three consecutive months. Papad was subjected to sensory evaluation. Product was assessed for appearance, texture, taste, aroma/flavor, colour and overall acceptability using 5 point hedonic scale.

Agrawal et. al., (2016) developed gluten free papad using buckwheat (Fagopyrum esculentum) and guar gum (Cyamopsis tetragonolobus) the Buckwheat was sieved for removing bran particle. The potatoes were washed for removing dirt and then boiled in the cooking casserole at 200-250°C for 30
minutes on gas. The potatoes were boiled and cooled down, then peeled and mashed. The mash was mixed with the buckwheat and guar gum, Rock salt was added in the ratio 53.5:38.5:4g and black pepper was also added to impart the taste and mixed gently. The clean water was used for making dough. After this the hands were greased with oil and small balls were made from the dough. Then the dough balls were pressed manually and the shape was given by papad mould. Then two polythene sheets were taken. Placing the papad on one sheet and covering it with another sheet to protect the papad from dirt. The papad was allowed to dry in the sun at approximately 38°C for two successive days, by which all the moisture was removed from papad. And then papad was either deep-fried or roasted. The papad was sealed in polythene with the help of polythene thermal sealer and stored at room temperature.

Awalgaonkar et al., (2015) prepared papads from Black gram incorporating Xylanase. Black gram (Vigna Mungo L.) and Xylanase was purchased from a local market of Mumbai city in India. Xylanase was used at (50 mg kg⁻¹ to 400 mg kg⁻¹) on the basis of black gram flour by dispersing it in minimum amount of water and using it with the balance water required for dough formation. Five different types of papads were prepared using Xylanase in the proportion of (0%, 50%, 100%, 200%, 300% and 400%) by mixing (50 g) salt, (10 g) papadkhar and (10 g) asafoetida and by adding (420 ml) water to (1 kg) black gram flour. Dough was kneaded with 20 ml oil and divided into small balls of 5 to 6 g each which were rolled on circular plates on smooth surfaces with wooden pin into discs of about 3 to 4 mm thickness and 15 cm diameter. The papads were dried in a tray drier at (313 ± 274 K) for 20 min and subsequently packed in polyethylene bags stored at room temperature (300 ± 275 K) in air-tight containers. The concentration of xylanase and time of resting (0.5-12 h) of the dough was subsequently optimized. The product was analyzed for proximate
composition such as physical and chemical evaluation. The papad show high acceptability as compared with control papad.

Renu and Waghray (2016) developed papad with legume using black gram and value addition with green leafy vegetables i.e., purslane leaves. All ingredients were mixed with appropriate amount of water and made into dough ball for control sample, also purslane leaves were added at different amount (10%, 15%, 20%, 25% and 30%) and black gram (100 g), black pepper (5 g), Hing (2 g), salt (5 g) and papadkhar (2.5 g). after doughing, small round balls were rolled and pressed manually. Pressed round shaped papads were then sun dried.

Siddiqui et. al., (2015) prepared papad by substituting black gram flour with finger millet and soy flour. Five different types of papads were prepared T₀, T₁, T₂, T₃ and T₄ they are T₀ (control papad), T₁ (10% finger millet, 10% soybean, 80% black gram papad), T₂ (15% finger millet, 15% soybean, 70% black gram papad), T₃ (20% finger millet, 20% soybean, 60% black gram papad) and T₄ (25% finger millet, 25% soybean, 50% black gram papad). Sensory evaluation indicated that the overall acceptability scores of Finger millet and soy papad T₂ were highest for fried papad.

Butti et. al., (2016) developed the papads from different sorghum varieties by incorporating finger millet flour and analyzed for physical, chemical and sensory qualities. Parbhani Moti sorghum variety was selected among five sorghum varities based on sensory evaluation of papads. Finger millet flour was added to Parbhani Moti sorghum variety based papad as (10%, 20%, 30%, 40%, and 50%) with other ingredients. The results revealed that Sorghum-finger millet papad prepared with 40% finger millet flour in sorghum flour was acceptable without any change in sensory, textural and quality parameters which shown significant increase in mineral content of sorghum-finger millet papad.
2.3. Sensory evaluation of papad prepared with incorporation of garden cress seed

Garg and Dahiya (2003) prepared papad from wheat-legume composite flours and studied its Nutritional and sensory attributes. Different blends of flour are mixed and papad were made such as Mung flour (control) – 600 g, Mung flour + wheat flour at (10, 20, 30%) level, Mung flour + chickpea flour at (10, 20, 30%) level, Mung flour + pea flour at (10, 20, 30%) level and papad were made. Papad were roasted and examined by a panel of judges using 9-point hedonic scale for their quality parameters like colour, appearance, flavor, texture, taste and overall acceptability. Mung flour (control) and chickpea flour supplemented papads had better scores as compared to pea flour and wheat flour supplemented ones. Both control and chickpea flour (20%) supplemented papads were found to be desirable whereas pea flour (10%) supplemented papads were found to be moderately desirable. Papads with chickpea flour (20%), wheat flour (10%), and pea flour (10%) level of supplementation of each flour were found to be most acceptable by the judges.

Senthil et. al., (2006) recorded the sensory and physico-chemical properties and positioned using canonical discriminant analysis (CDA) twelve commercial sample of black gram papad were procured from local market and were coded S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11 and S12. It can be seen that there was a significant difference among the samples for the attributes blisters and salty. Among the samples, S9 had the lowest score for the attribute blisters (3.75) and samples S10 and S11 had the highest score of (6.24 and 6.27), respectively; samples having small blisters spread uniformly over the surface were rated high. The sample S4 had more saltiness as given by the score of (8.13), whereas saltiness was significantly less in sample S6 (5.88). The majority of the samples had lower intensity scores for the attributes oilyness, blisters, oily aroma and alkaline. The black gram aroma was greater in S2, S4, S5, S7, S8 and S12, as
evidenced by the high scores (greater than 8) on the quantitative descriptive analysis scale. The yellow tinge was more pronounced in S1, S2, S4, S8, S9 and S12, and positive correlation (0.67) was found between the sensory score for yellow color and $b^*$ values. All the samples had good overall quality as shown by a score greater than 8 and there was no significant difference in overall quality for all the samples.

Awalgaonkar et al., (2015) reported on the effective use of xylanase on the addition properties of papad dough and further the effects on quality of papads processing. Further papad were analyzed for the sensory evaluation which was done by a panel of 10 members who are familiar with the product since childhood using a hedonic scale of 1 to 10 with 1 to 2: very poor, 3 to 4: poor, 5 to 6: medium, 7 to 8: good, 9 to 10: very good. The age of the panelists ranged from 18 to 25 with equal number of males and females. Sensory evaluation of enzyme treated and control fried papads did not show any significant differences in overall acceptability by the sensory panel used in the study. The panel members in fact reported the mouth feel of the enzyme treated papad to be better than the control. Xylanase at 100 mg kg$^{-1}$ was therefore optimized for further studies as it eased the dough handling without affecting the final product quality. Sonawane et al., (2015) studied effect of incorporation of green leafy vegetables on bioactive components of papad in Indian snack food. An attempt has been made to increase phenolic contents and antioxidant capacity by incorporating green leafy vegetables viz., ambadi and ambat chukka in the range of (10 to 30%). Sensory analysis of papad was carried out after frying. Sensory evaluation was carried out using 9-point hedonic rating scale in laboratory at ambient conditions. Ten trained panelists were selected. They were healthy postgraduate (M. Tech and Ph.D) students of Food Technology between age group of 23 to 30 years without any medical disorder. Sensory panelists were asked to rate and give score for different parameters for papad as appearance, colour, texture, mouth-feel, flavor, taste and
The effect of incorporation of ambadi and ambat chukka fresh leaves shown on sensory parameters of vegetable papad. It can be seen that when papad was prepared by incorporating 10% ambadi, highest sensory score for taste (7.4), texture (7.3) and color (7.1) was received compared to control papad taste (7.2), texture (6.8) and color (6.8). When papad was prepared by adding 20% ambat chukka; highest sensory overall acceptability score was received as compared to other concentration of ambat chukka incorporated papad. Sensory score received for 20% ambat chukka incorporated papad for taste, texture and color were (6.7, 7.0 and 7.2), respectively while control papad had received sensory score (7.2, 6.8 and 6.8) for taste, texture and color respectively.

Khan et al., (2015) studied the quality of papad made from blends containing kodo, soya bean, sago, green gram and rice was as good as prepared from soya fortified millet papad. Different types of blend papad were developed from cereals minor millets and pulses flour and subjected to sensory test on 9 point hedonic scale from the sensory mean scores and the comments or the panel list best combinations were selected KR3 = kodo : rice (40:60) with overall acceptability (8.4), KS2 = kodo :sago (60:40) (7.7), KG3 = kodo : green gram (85:15)(7.6), and KSO2 = kodo: soya bean (90:10) (8.6), respectively.

Agrawal et al., (2016) developed gluten free papad using buckwheat (Fagopyrum esculentum) and guar gum (Cyamopsis tetragonolobus) and studied the proximate, physico- chemical and sensory analysis of papad. The prepared papad allow for sensory evaluation with parameters such as Appearance, Texture, Taste, and Flavor scores varied from (7.35 to 7.8) indicating that the Buckwheat papad was acceptable. The mean acceptability of papad was (7.61) which was more than acceptability level 5. The acceptability parameter was checked by 10-untrained sensory panelist member followed by 9-point hedonic scale.

Renu and Waghray (2016) developed value added traditional savoury with green leafy vegetables (purslane). Further, prepared papad were allow to
proximate and sensory evaluation. Papad were fried and subjected for sensory evaluation. A total of 30 semi-trained panelists judged the sample on a 9-point hedonic scale, where 9 denotes “dislike extremely” and 1 “like extremely” for the attributes like color, appearance, texture, taste, flavour, after taste and overall acceptability. All sample are quality accepted according to the score given by panelist for their color, texture and appearance compared to control. But in terms of taste and flavor, papad with 15% incorporated purslane leaves were preferred more over control.

2.4. Physico-chemical properties of papad

Rahman and Uddin (2008) prepared papad from Mungbean, Grasspea (Khasari dal), Black gram (Mashkolai dal) incorporating soya flour. All the ingredients were collected from the local market. Five different types of papads were prepared using (0%, 5%, 10%, 15%, 20%) soya flour with pulses and other ingredients. The products were analyzed for proximate composition, chemical analysis and self-life evaluation. The moisture, protein, fat, ash and total carbohydrate content in the dried papads samples were found in the range of (10.10 to 10.33%), (24.13 to 28.03%), (1.06 to 5.35%), (1.53 to 1.97%) and (54.55 to 62.95%), respectively.

Nazni and Pradheepa (2010) determined the physico-chemical properties of papad prepared from jowar millet flour. Product were analyzed for proximate composition, physical and chemical analysis and organoleptic evaluation. The result revealed that moisture, protein, fat, ash and total carbohydrate content in the dried papads samples were found in the range of (7.06 to 8.36 %), (8 to 16 %), (4.05 to 5.3 %), (2.5 to 4.5 %) and (67.34 to 77.89 %), respectively. The samples were highly acceptable by the subjects and physical properties were almost same with control papads. No remarkable changes in moisture content, texture and flavour were observed up to 6 months of storage in ambient condition (27 °C to 35°C) indicating that the products were shelf-stable up to 6 months.
Garg and Sabharwal (2013) optimized papad using amylase rich fieldpea and to studied the effect of processing on nutritional quality by analyzing proximate nutrients, total minerals, and antinutrients using standard methods. All the values are average triplicate values. The preparation of amylase rich flour from fieldpea was carried out after soaking, germination, drying, dehulling and finally grinding it to fine powder. Papad was prepared using roasting processing treatment. Moisture content of fieldpea papad (8.10 %) was significantly (P<0.05) lower than the unprocessed mixture (10.01 %). Results indicated that there were non-significant differences in crude protein, crude fat and total ash content of unprocessed mixture as well as processed fieldpea papad. The crude fibre content of unprocessed (raw) mixture was (4.14 %) whereas processed papad contain (3.4 %) crude fibre. The carbohydrate content of unprocessed and processed papad differed significantly (P<0.05). In unprocessed mixture and processed papad (125.64) and (114.39 mg/100g) of Ca content was present respectively. Processing showed significant (P<0.05) effect on iron content of papad. In the unprocessed mixture (3.41 mg/100g) Zn was present while after processing (3.28 mg/100g) Zn was present. Total soluble sugar of fieldpea papad (6.87%) differed significantly (P<0.05) from its unprocessed mixture (6.03%). The processing treatment significantly (P<0.05) reduced the level of phytic acid, polyphenols and Trypsin inhibitor activity. Thus fieldpea papad can be easily used as a healthy snack. Also because of the low cost it could be easily incorporated in the daily diet.

Suradkar et. al., (2014) analyzed the papad parameters chemical and physically. The moisture, protein, fat, ash and total carbohydrate content of treatment T2, T3, T4 and T5 was found to be ranging from (11.00 to 11.85 %), (24.90 to 29.25 %), (2.9 to 6.24 %), (1.45 to 1.95 %) and (58.09 to 50.71 %), respectively. The protein content was found to be increasing significantly with addition of soya flour.
Chavan et al., (2015) investigated the nutritional composition and sensory characteristics of sorghum papad. Five varieties and two hybrids were used for preparation of sorghum papad. The crude protein content in grain and papad ranged from (10.28 to 11.37 %) and (10.11 to 11.35 %), respectively. The variety M-35-1 gave numerically higher level of protein. The fat content in grain ranged from 1.21 to (1.90 %). The genotype Dadar local gave higher level of fat (1.90 %) as compared to other genotype, the oil content in sorghum papad ranged from (23.59 to 35.42 %). The hybrid SPH-1620 gave numerically higher level of fat percentage as compare to other genotypes. The new genotype RPASV-3 identified for the preparation of sorghum papads showed slightly higher level of protein, fibre and phenolics content. The total sugar, fat and ash content are less than other cultivar studied.

Khan et al., (2015) evaluated proximate composition of different types of blended papad which was developed from cereals minor millets and pulses flour such as kodo : rice, kodo : sago, kodo : green gram, kodo: soya bean. Results revealed that he moisture content of four samples varies from (11.12 to 12.2 %), protein (8.72 to 11.98 %), fat (1.4 to 3.03 %), ash (1.16 to 3.05 %), and carbohydrates (59.87 to 71.37 %) and fiber (3.7 to 7.3 %) respectively. Moisture content decreased with formulation of various pulses grits. Similarly, carbohydrate content was significantly differing in all fortified papad.

Siddiqui et al., (2015) utilized finger millets and soy flour for preparation of papad. Further, papad were allowed to determine the chemical composition, texture and flour of papad. Papad were made into circular shape with thickness generally varied from (0.3 to 2 mm) and is dried by different means to a moisture level of (14–15%). Five different types of papads were prepared T0, T1, T2, T3 and T4 they are T0 (control papad), T1 (10% finger millet, 10% soybean, 80% black gram papad), T2 (15% finger millet, 15% soybean, 70% black gram papad), T3 (20% finger millet, 20% soybean, 60% black gram papad) and T4 (25% finger
millet, 25% soybean, 50% black gram papad). Sensory evaluation indicated that the overall acceptability scores of Finger millet and soy papad T2 were highest for fried papad. Nutritional value of T2 was also noticed to be higher when compared with control sample. The proximate analysis showed that the sample T2 had moisture content of (10.20 %), protein content of (27.12 %), fat content of (3.21 %), ash content of (1.81 %) and total carbohydrates content of (57.66 %), respectively.

Agrawal et al., (2016) investigated the physical and chemical properties of gluten free papad using buckwheat (*Fagopyrum esculentum*) and guar gum (*Cyamopsis Tetragonolobus*). The physical properties of the papad were determined. The diameter of papad was 7.5 cm. regarding the weight 3.98g was obtained. Regarding kneading time for Buckwheat papad, the time was 20 minutes. The diameter of dry papad changed individually depending upon the shrinkage occurred in papad. About the time taken for frying, the maximum time was 8 seconds. The diameter of fried papad was about (6.5 cm) and weight was (1.86 g) and chemical properties shown the moisture content of papad was (5.14 %), ash (6.8%), Fat (4.5 %), protein (4.2%), carbohydrate (81.3%), respectively.

Butti et al., (2016) noticed physico-chemical characteristics and sensory qualities of sorghum-finger millet papad. Papads were prepared from different sorghum varieties by incorporating finger millet flour and analyzed for physical, chemical and sensory qualities. Parbhani Moti sorghum variety was selected among five sorghum varities based on sensory evaluation of papads. Finger millet flour was added to Parbhani Moti sorghum variety based papad as (10 %, 20 %, 30 %, 40 %, and 50 %) with other ingredients. The results revealed that Sorghum-finger millet papad prepared with (40 %) finger millet flour had moisture range of (9 to 9.25%), proteins (8.39 to 12.64 %), fat (0.88 to 1.05 %), ash (0.54 to 1.27%) and total carbohydrates (76.77 to 80.21%), respectively.
2.5. Storage with different packaging material

Garg and Dahiya (2003) developed papad from wheat and legumes blends and analyzed them for organoleptic acceptability, nutritional quality, and keeping quality. Raw papads were stored for 30, 60, and 90 days at room (37°C) and refrigeration (7–10 °C) temperature. Sensory evaluation of the stored papads was done by a semi trained panel of 10 judges using 9-point Hedonic scale. Control and chickpea flour (20%) supplemented papads were found to be desirable up to 60 days of storage both at room and refrigerated temperatures. After 60 days, a significant decrease in overall acceptability of papads was found but they were moderately desirable. Pea flour (10%) supplemented papads were moderately desirable up to 90 days of storage. But they were found to be slightly desirable up to 90 days of storage. However, a significant decrease in the overall acceptability of wheat flour (10%) supplemented papads was found after 30 days of storage and they were found to be slightly desirable up to 90 days of storage. So, the papads other than wheat flour supplemented ones can be stored safely for 60 days both at room and refrigerated temperatures. Cowpea papads also showed excellent quality upto a storage period of 4 months.

Nazni and Pradheepa (2010) developed papad from jowar millets flour. The product was analyzed for proximate composition, physical and chemical analysis and organoleptic evaluation. The shelf life of the processed papad was studied for a period of 6 months at ambient conditions (room temperature). No remarkable change in moisture content, texture and flavour were observed upto 6 months of storage. After 5 months of storage greater increase in moisture content was noticed. The papad samples became less crisp and also developed rancid flavour. The processed jowar fortified papad samples were shelf-stable up to 5 months of storage at ambient conditions. No remarkable change in moisture content, texture and flavour were observed up to 6 months of storage in ambient conditions indicating that the products were shelf-stable up to 6 months.
Veena et. al., (2012) reported new advances in Food Technology and packaging increased the interest in healthy eating of more nutritious foods. Different Packaged materials were used polyethylene covers, plastic boxes and steel boxes to store soy papads. The study proved that steel and plastic containers could be used as a better storage material for value added dry products at domestic level. Soy incorporated papad found to be superior than traditionally prepared with respect to nutritional, microbial, storage quality and ultimately the acceptability.

Suradkar et. al., (2014) prepared soya fortified urad papad with different levels of soya flour. The papads along with control sample were stored at ambient temperatures (25°C to 30°C) for a period of 120 days. The stored papads were analysed at an interval of 30 days. During storage studies the change in moisture content, texture and flavour were observed. The storage study results reveals that, the soya fortified urad papad can be stored safely at normal conditions (25°C – 30°C) for a period 90 days without considerable changes in the quality attributes. However papad lose their crispiness after a period of three months. The moisture content was found to be increasing slightly as storage period advances. Reported the papads packed in the polythene bags can be stored safely for a period of 90 days at temperature of (27°C – 35°C). The 120 days storage study shows that papad are remains good and palatable up to 90 days. Hence we can successfully utilize the soybean for fortification of urad papad.

Kaur and Aggarwal (2015) developed papads from potato and rice blends and to analyze them for organoleptic, physicochemical, bioactive and shelf life quality. Papads were packed in 200 gauge polythene bags and sealed in tight air containers. Sensory evaluation indicated higher overall acceptability scores of potato enriched papads compared to control. During storage of papads at room temperature for up to 3 months, significant (p < 0.05) changes in the moisture content, bioactive content and antioxidant activity were observed. Storage studies
showed that the potato supplemented papads can be stored safely for 3 months at ambient temperature.

Sonawane et. al., (2015) studied the effect of incorporation of green leafy vegetables on bioactive components of papad - an Indian snack food. Dried papads were stored at two different temperatures viz., low temperature (LT, 30°C) and high temperature (HT, 40°C) for 30 days to study the effect of storage conditions on phenolic content and antioxidant capacity. Control papad on zero days showed TPC of 0.53 mg GAE/g. However no significant decrease in TPC was observed on 10th day of storage at LT. Whereas on 20th day TPC was decreased to 0.37 mg GAE/g and decreased further to 0.32 mg GAE/g on 30th day. Papad stored at HT showed significant decrease in TPC on 10th day storage (0.46 mg GAE/g) and significantly decreased further to 0.28 mg GAE/g on 20th day. There was no significant difference in TPC on 30th day of storage. 10% ambadi incorporated papad showed decrease (0.85 to 0.48 mg GAE/g) in TPC from zero days to 30 days at LT, whereas at HT TPC significantly decreased upto 20th day and further on 30th day no significant difference was found. The TPC in 20% ambat chukka incorporated papad showed no significant difference on 10th day of storage at low temperature as well as at high temperature, further it significantly decreased up to 30th day in both storage conditions. It is clear that total phenolic content in papad is mostly stable at LT. During storage period an antioxidant capacity in control, ambadi and ambat chukka incorporated papad showed significant decrease at low temperature. Antioxidant capacity quantified by ABTS method showed no significant difference at HT in control papad after 30 days of storage. However antioxidant capacity measured by DPPH method showed a significant decrease on the 30th day in all papads when stored at HT. This could be because of the stability of polyphenols and antioxidant capacity in food is influenced by many external factors such as exposure to light, air and different storage temperatures.
Agrawal et. al., (2016) revealed the shelf of the processed papad for a period of 1 month at ambient condition (room temperature). No remarkable change in moisture content, texture, and flavor were observed up to 1 month of storage. The papad sample was shelf–stable up to 5 months of storage at ambient conditions.

2.6 Microbial quality of papad

Gowri and Vasantha (2012) reported the microbial quality of food items prepared by women who are involved in food processing trade in the unorganized sector with regard to various parameters like adopting food safety and hygienic methods, food safety laws for food production. The bacteria count in curry leaves papad, Chikki, tomato jam, Murukku, papad, Ragi puttu, Rusk, potato bonda, grape squash are $3 \times 10^{-6}$ cfu/g. The fungi count in curry leaves papad, Athirasam, pappad, Ragi puttu, Rusk, Sathumavu, Bajji, Murukku, Chikki, Pappad are $1 \times 10^{-4}$ cfu/g and Tomato jam, Amla Murappa, Green gram ball, Vadai, Grape squash are $2 \times 10^{-4}$ cfu/g.

Unhale et. al., (2012) reported that sorghum roti prepared with varying concentration of potassium sorbet and ascorbic acid were subjected microbial analysis. Total plate count, and yeast and mould count were estimated by using nutrient agar and potato dextrose agar respectively with the help of pour plate technique. The microbial count was taken up to 18 days at the interval of three days after preparation. The results were expressed in terms of colony forming unit (CFU)/ per g of sample. There was growth of molds on the surface of roti. The growth of bacteria was in increasing order in first four days and then their population goes on decreasing. The growth of yeasts and molds also goes on increasing.

Veena et. al., (2012) studied the microbial quality parameters of papad incorporated with soy flour. Total plate counts (microbes) at the end of the storage
period were within the safe limits prescribed by BIS. The product were subjected for chemical and microbial analysis after three months of storage. Microbial contamination was estimated by analyzing microbial load in stored papads by using Nutrient Agar (Na) for bacteria and spore, Martin’s Rose Bengal Agar (MRBA) for molds/ Fungi and for yeast Davis yeast salt agar. Following the dilution pour plate method. The three dilutions $10^{-2}$ were used for analyzing bacteria, mould, spores and yeast respectively. Maximum number of bacteria and yeast counts were present in the papad stored in polyethylene covers followed by plastic and steel boxes.

Agrawal et. al., (2016) reported the microbial quality of gluten free papad using buckwheat buckwheat (Fagopyrum esculentum) and guar gum (Cyamopsis Tetragonolobus). The Total Plate Count (TPC) was nil at initial stage of storage. The effect of storage on the quality of papad was assessed during period of 3 months with an interval 15 days .TPC was not observed up to 3 months of storage. Yeast and Mold count in different blended papad (control) was nil at initial stage of storage not recorded up 2 months of storage, while in the completion of 3 months of storage the count of Yeast and mold were $1.0 \times 10^1$, $1.0 \times 10^1$cfu/g, respectively.
Chapter III

MATERIAL AND METHODS

The present investigation entitled “Studies on effects of gardencress seed (Lepidium sativum L) incorporation on the quality of black gram (Vigna mungo L) spiced papad” was carried out in the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani. During academic year 2017-2018. This chapter contains relevant information regarding the research design and methodological steps. The research methodology and procedures adopted to achieve the objectives of the present study have been described under the following suitable headings:

3.1. Material

3.1.1. Procurement of materials for Papad

Raw materials required during present investigation were procured from local market of Parbhani such as gardencress seed, black gram split, black pepper powder, edible common salt, edible oil, papadkhar, compound asafetida etc. the raw material were cleaned and made free from husk and other foreign matters.

3.1.2. Equipments

The equipments and machineries like domestic mixer (for grinding of gardencress seed and black gram), texturometer (Stable Micro System TAXT2 plus), Colour measuring instrument – Colorflex EZ, required in the present investigation were used, these equipments were available in the College of Food Technology and College of Horticulture, VNMKV, Parbhani.

3.1.3. Utensils

The required utensils were used from the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani.
3.1.4. Chemicals and glassware’s

All the Chemicals used in this study were of analytical grade and required glassware’s were available in the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani.

3.1.5. Packaging materials

Different packaging materials used such as HDPE, Aluminium pouches and steel container were purchased from the Parbhani market.

3.2. Methods

3.2.1. Physical Properties of Garden cress seed and Black gram seed

3.2.1.1. Color

The colour of garden cress seed and black gram seed was determined by visual observations.

3.2.1.2. Shape

The shape of seed was determined by visual observation

3.2.1.3 Thousand Kernel weight

It was calculated by weighing 1000 sound grains of garden cress seeds and black gram seed on a digital weighing balance.

3.2.1.4. True Density

25 g of garden cress seeds were taken and filled into the measuring cylinder and volume occupied by grains was measured and expressed in g/ml. It was calculated by using following formula:

\[
\text{True Density (}\rho\text{)} = \frac{\text{Weight of grains}}{\text{Volume occupied}}
\]
3.2.1.5. Bulk Density

25 g of sound grains were weighed on the digital weighing balance and filled into the measuring cylinder earlier filled with reference solution of Hexane. The increase in the level of liquid was measured after adding the grains and represented in g/L. It was calculated by using following formula:

\[
\text{Bulk Density (}\rho'\text{)} = \frac{\text{Weight of grains}}{\text{Volume displayed}}
\]

3.2.1.6. Porosity

Porosity is the per cent of the volume of inter grain space to the total volume of grain space. It is represented as per cent porosity.

3.2.1.7. Angle of Repose

It is the steepest angle between the base and slope of cone formed on a free vertical fall of grain mass to a horizontal plane when material is free falling or sliding. It was determined by making a circular pile of the grains freely falling. The height of the pile was taken (h) and its radius (r) is also taken. Angle of repose was then calculated by following formula.

\[
\text{Angle of Repose (}\theta\text{)} = \tan^{-1}\left(\frac{h}{r}\right)
\]

3.3. Formulation for preparation of gardencress seed papad

3.3.1. Formulation of Garden cress incorporated papad

Papad prepared with incorporation varying levels of gardencress seed powder with black gram flour were investigated. The formulation was made by varying levels of gardencress seed and black gram flour viz., 100:00, 90:10, 80:20 and 70:30 percent respectively and data given are illustrated in table 1.
Table 1. Formulation for preparation of Garden cress powder papad

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black gram</td>
<td>100 g</td>
<td>90 g</td>
<td>80 g</td>
<td>70 g</td>
</tr>
<tr>
<td>Garden cress powder</td>
<td>0 g</td>
<td>10 g</td>
<td>20 g</td>
<td>30 g</td>
</tr>
<tr>
<td>Black pepper powder</td>
<td>0.5 g</td>
<td>0.5 g</td>
<td>0.5 g</td>
<td>0.5 g</td>
</tr>
<tr>
<td>Edible common salt</td>
<td>0.6 g</td>
<td>0.6 g</td>
<td>0.6 g</td>
<td>0.6 g</td>
</tr>
<tr>
<td>Compound Asafoetida</td>
<td>0.5 g</td>
<td>0.5 g</td>
<td>0.5 g</td>
<td>0.5 g</td>
</tr>
<tr>
<td>Edible oil</td>
<td>15 g</td>
<td>15 g</td>
<td>15 g</td>
<td>15 g</td>
</tr>
<tr>
<td>Papadkhar</td>
<td>4.5 g</td>
<td>4.5 g</td>
<td>4.5 g</td>
<td>4.5 g</td>
</tr>
<tr>
<td>Water</td>
<td>50 ml</td>
<td>50 ml</td>
<td>50 ml</td>
<td>50 ml</td>
</tr>
</tbody>
</table>

Where, **T0**- 100 g black gram flour + 0 g Garden cress flour  
**T1**- 90 g black gram flour + 10 g Garden cress flour  
**T2**- 80 g black gram flour + 20 g Garden cress flour  
**T3**- 70 g black gram flour + 30 g Garden cress flour  

Black pepper powder, edible common salt, compound asafoetida, edible oil papadkhar and water were used at 0.5, 0.6, 0.5, 15, 4.5 and 50 per cent levels respectively in each formulation of papad.

### 3.4. Processing of Raw materials

#### 3.4.1. Preparation of garden cress powder (GCSP)

Raw materials such as Garden cress seeds used for papad preparation were cleaned and roasted in a vessel at 110°C for 10 min. and then ground to fine powder, sieved and stored in air tight container as shown in flow sheet 1 as per method given by Kaur and Sharma (2015).
Flow sheet 1. Preparation of Gardencress seed powder

Selection of Gardencress seed
    ➔
Cleaned to remove dirt, dust etc.
    ➔
Roasting in a vessel at 100°C for 10 min.
    ➔
Cooling at room temperature
    ➔
Grinding
    ➔
Sieved
    ➔
Gardencress seed powder
    ➔
Packing in air tight container

3.4.2. Preparation of black gram flour (BGF)

The clean and healthy seeds of black gram split were taken for preparation of Black gram flour (BGF). The seeds were dehulled in order to separate out hulls and dal. The split dhal obtained was finely ground in a flour milling and passed through a 60 mesh size sieve as shown in flow sheet 2. The powdered sample of BGF was stored in an air tight container until further use for various studies.

Flow sheet 2. Preparation of Black gram flour

Black gram
    ➔
Cleaning
    ➔
(Remove dust and foreign particles)
    ➔
Grinding
    ➔
(In flour milling and passed through 60 mesh sieve)
    ➔
Refining
    ➔
Packing in still container
    ➔
Storage at 27°C-32°C temperature
3.5. Preparation of papad

Black gram flour (BGF) and Garden cress seed powder (GCSP) were mixed with different variation as per table 1 with other ingredients such as black pepper powder, edible common salt, compounded asafoetida, edible oil and papadkhar. Then dough is kneaded with addition of water and divided into small balls of 10 g for obtaining same size papads. The detail procedure used for preparation of gardencress seed powder papad is presented below in flow sheet 3 as per method given by Siddique et al., (2015).

**Flow sheet 3. Preparation of papad**

- **Black gram flour**
- **Blending (BGF+ GCSP) (90:10)**
- **Gardencress powder**
- Addition of various additive i.e., Black Pepper powder, edible common salt, Compounded Asafoetida, Papadkhar, Edible oil
- Pour the mix in boiling water (100°C)
- Stir well to prepare soft dough
- Divide into small balls (10 g)
- Papad prepared manually
- Dry the papad at room temp. for 6-8 hrs.
- Pack and store the dried papads in the HDPE bags
3.6. Physical quality attributes of raw and fried gardencress seed papad

Various physical quality characteristics like thickness, diameter, expansion ratio and weight of papad (before and after frying) were determined.

The expansion percentage of fried papad was calculated according to the procedure given by Awalgaonkar et al., (2015) by using following formula:

\[
\text{Expansion (\%) } = \frac{\text{DF} - \text{DR}}{\text{DR}} \times 100
\]

Where, DF = diameter of fried papad
DR = diameter of raw papad

3.7. Determination of colour characteristics

The colour of raw and toasted gardencress seed papad prepared from different combinations were measured using hunterlab colorimeter (Colorflex EZ) in terms of Colour (L*, a*, b* values) of the samples. L* is known as the lightness and extends from 0 (black) to 100 (white). The other two coordinates a* and b* represents redness (+ a) to greenness (- a) and yellowness (+ b) to blueness (- b), respectively were recorded. Three measurements will be taken for each sample and their means reported Awalgaonkar et al., (2015).

3.8. Proximate analysis

Different chemical properties of samples were analyzed for moisture content, ash, fat, protein and total carbohydrate. All the determinations were done in triplicate and the results were expressed as the average value.

3.8.1. Determination of Moisture

Moisture was estimated by accurately weighing the 5 g sample, it was ground and subjected to oven drying at 105°C for 4 hr. It was again weighed after cooling in desiccators until constant weight. The resultant loss in weight was calculated as moisture content (AOAC 2000).
Loss in weight

\[
\text{% Moisture content} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100
\]

3.8.2. Determination of Ash

5 g sample was weighed into silica crucible and heated at low flame till all the material was completely charred and cooled. Then it was kept in muffle furnace for about 4 hrs. at 600\(^{0}\)C. It was again cooled in desiccator and weighed and repeated until two consecutive weights were constant. The per cent ash was calculated by knowing the difference between the initial and final weight (AOAC 2000).

\[
\text{% Ash content} = \frac{\text{AW}}{\text{IW}} \times 100
\]

Where,

- AW = Weight of Ash
- IW = Initial weight of dry matter

3.8.3 Determination of Fat

5g ground sample was weighed accurately in thimble and defatted with petroleum ether in Soxhlet apparatus for 6 to 8 hrs. at 60\(^{0}\)C. The resultant ether extract was evaporated and lipid content was calculated (AOAC 2000).

\[
\text{% Crude Fat} = \frac{\text{Weight of dried ether soluble material}}{\text{Weight of sample}} \times 100
\]
3.8.4 Determination of Protein

Protein was determined by Micro-Kjeldahl method using 0.2 g of ground sample by digesting the same with concentrated sulfuric acid (H\textsubscript{2}SO\textsubscript{4}) containing catalyst mixture for 3 to 4 hrs. at 70°C. Then it was distilled with 40 per cent NaOH and liberated ammonia was trapped in 4 per cent boric acid containing mixed indicator (Methyl red : Bromocresol green :: 1:5) and then it was titrated with 0.1N HCL. The per cent nitrogen was calculated and protein percentage was estimated in the sample by multiplying with appropriate factor. To calculate protein content %N was determined by given formula- (AOAC 2000).

\[
\frac{T_s - T_B \times \text{Normality of acid} \times 0.014}{\text{Weight of sample}} \times 100
\]

Where,

- \(T_s\) = Titer volume of the sample (ml),
- \(T_B\) = Titer volume of Blank (ml),
- 0.014= M eq. of N\textsubscript{2}.
- % Protein = Nitrogen \times 6.25

3.8.5 Determination of Carbohydrates

This was essentially performed by method suggested by Ranganna (1986). The sample was weighed (0.5 g) accurately in test tube and kept in ice water bath for few minute followed by the addition of cold H\textsubscript{2}SO\textsubscript{4} (72 per cent) with gentle stirring. The viscous paste was diluted with distilled water to obtain final concentration 2 N with respect to acid. It was then refluxed at 98°C for 3 to 4 hours to achieve complete hydrolysis. The sugar content was estimated by Phenol-H\textsubscript{2}SO\textsubscript{4} method, using glucose as standard. The orange yellow color was read at
480 nm on spectrophotometer. From the calibrated curve the concentration of sugar in hydrolysate was calculated and per cent total sugar in the sample was quantified (AOAC 2000).

3.8.6. Determination of Minerals

The ash solution was prepared by wet digestion method of Jackson (1967) to determine the content of Potassium, Phosphorous, calcium, iron and zinc.

3.8.6.1. Mineral solution preparation

The ash obtained by above procedure was moisture with glass distilled water (0.5-1 ml) and concentrated HCl was added and evaporated to dryness on a boiling water bath. Again 5ml concentrated HCl was added and evaporated to dryness as before. Lastly 4ml of HCL and 5ml of distilled water were added. This solution was warmed over a boiling water bath and filtered into the 100ml of volumetric flask using Whatman No.4 filter paper. After cooling the volume was made to 100ml using distilled water and suitable aliquot was used for the estimation of Calcium and Iron.

3.8.6.1.2. Preparation of reagents

3.8.6.1.2.1. Di acid solution

Di acid solution was prepared by mixing concentrated nitric acid and perchloric acid in the ratio of 5:1.

3.8.6.1.2.2. Procedure

An accurately weighed amount of 2.0 g of each sample of the selected food was taken in 50 ml conical flask, in triplicate. A volume of 5 ml of concentrated nitric acid was added into each flask. The contents were heated for 30 min on water both and again for 30 min on hot plate. Then a volume of 20 ml of di acid mixture was added into each flask and digestion was allowed to continue on hot plate, until the dense white fumes of perchloric acid were involved and the contents in the flask become colourless. After allowing the content in each flask to cool, the content of conical flask was transferred to a 100 ml of volumetric
flask, rinsing thrice with glass distilled water. The volume was then made up to
100 ml with distilled water and mixed well. This solution was taken for
determination of Potassium, Phosphorous, calcium and trace minerals.

3.8.6.1.2.3. Potassium

It was determined by flame photometric method as given by Ranganna
(1995). Potassium in solution is atomized into an oxyhydrogen or oxyacetylene
flame. The flame excites atoms of potassium causing them to emit radiations at
specific wavelengths. The amount of radiation emitted is measured on a
spectrophotometer. Under standard conditions, it is proportional to the
concentration of potassium in solution.

\[
\text{Potassium (mg / 100g)} = \frac{\text{ppm found from standard curve} \times \text{Volume made up} \times \text{Dilutions if any} \times 100}{\text{Weight of sample} \times 1000}
\]

3.8.6.1.2.4. Phosphorus

Exactly 0.5 ml of the ash solution of each of the samples was pipetted into
15 ml of glass stopped centrifuge tube, 1.0 ml of ammonium molybdate solution,
1.0 ml of hydroquinone solution and 1.0 ml of sodium sulphite solution were
added and mixed well. The content in each tube, were diluted to 15 ml with glass
distilled water, mixed well and allow to stand for 30 min. Intensity of the
developed colour was read at 660 nm on spectrophotometer. The concentration of
phosphorus in the samples was read from stand curve.

3.8.6.1.2.5. Calcium

25 ml mineral solution was diluted to 150 ml with distilled water and
neutralized with ammonia solution using methyl red as indicator till pink color
changes to yellow. Further the solution was boiled and 10 ml of 6 percent
ammonia oxalate was added. This mixture was boiled for few minutes and added
with concentrated glacial acetic acid (99.9 percent) till the color change was
distinctly pink. The mixture was kept aside in warm place (overnight) and when
precipitate settled down, the supernatant was tested with a drop of ammonium oxalate to ensure the completion of precipitation. The content were filtered through Whatman No.4 filter paper and given washings of warm distilled water. The precipitate was transferred to a beaker by making a hole in the centre of filter paper and by giving washings of H₂SO₄ (2 N, 5ml) twice. Then solution was heated to 70°C and titrated against N/100 KMNO₄, simultaneously a blank was also run.

1ml of 0.01N KMNO₄ = 0.2004 mg calcium.

3.8.6.1.2.6. Iron

Pipette 10 ml aliquot of ash solution into 25 ml volumetric flask, and add 1 ml hydroxylamine hydrochloride solution. After 5 min, add 5ml buffer solution add 1 ml O- phenanthroline solution or 2ml of dipyridyl solution and dilute to volume. Determine absorbance of solution at 510 nm. From absorbance reading, determine Fe content present in aliquot of ash solution taken by referring to standard curve.

3.8.6.1.2.6.1. Preparation of standard curve

Pipette 0.0, 0.5, 1.0, 1.5, 2.0, 3.0 and 4.0 ml of Fe standard solution into a series of 25 ml volumetric flasks and add to each of them exactly 0.2 ml of conc. HCL. Dilute each of them to exactly 10 ml with water, and then add reagents in the same way as for the sample, Plot the quantity of Fe (in mg) against the absorbance.

Iron content of sample (mg Fe / 100 gm sample) =

\[
\frac{\text{Quantity of Fe in aliquot of ash solution (from calibration curve)}}{\text{Total volume of ash solution X 100}} \times \frac{\text{Aliquot of ash solution taken for determination}}{\text{Wt. of the sample taken for ashing}}
\]
3.8.6.1.2.7. Zinc

Zinc content of samples and developed Products was estimated by Atomic absorption spectrophotometer. (AACC 2000).

3.9 Antinutritional factors in processed of Garden cress seed and Black gram

3.9.1. Estimation of tannin contents

Tannin contents of flour were measured by Folin-Denis method Schanderi (1970).

3.9.1.2. Preparation of Folin-Denis reagent

Sodium tungstate (100 g) and phosphomolybdic acid (20 g) were dissolved in 750 ml distilled water and later 50 ml phosphoric acid was added into the solution. Mixture was refluxed for 2 hrs. and volume was made to one liter with distilled water.

3.9.1.3. Preparation of carbonate solution

Sodium carbonate (350 g) was dissolved in one liter water at 70°C. Solution was allowed to stand overnight and then it was filtered through glass-wool.

3.9.1.4. Preparation of standard tannic acid solution

Tannic acid (100 g) was dissolved in 100 ml distilled water.

3.9.1.5. Preparation of working solution

5 ml stock solution was diluted to 100 ml with distilled water. Each ml contained 50 µg of tannic acid.

3.9.1.6. Procedure Ground sample

(0.5 g) was taken in a 250 ml conical flask and 75 ml distilled water was added to it. It was heated and boiled for 30 min and then centrifuged at 2000 rpm for 20 min. The supernatant was collected in 100 ml volumetric flask and volume was made up to the mark. In a 100 ml flask containing 75 ml water, 1 ml sample extract, 5 ml Folin-Denis reagent and 10 ml sodium carbonate solution were added and volume was made up. Contents of the flask were shaken well and then
absorbance was measured at 700 nm after staying for 30 min. A blank was prepared with water instead of sample and standard graph was produced by using 0-100 µg tannic acid.

3.10. Phytate content

Phytate content in legume meals was determined by procedure elaborated by Haug and Lantzsch (1983).

3.10.1. Preparation of phytate reference solution

Sodium phytate (0.15 g) was dissolved in 100 ml de-ionized water. Reference solution was prepared by diluting the stock solution in the range of 1.2 to 11.7 ml stock solution (1.2, 2.7, 4.2, 5.7, 7.2, 8.7, 10.2, 11.7 ml) in 100 ml volumetric flask and made the volume with 0.2N HCl.

3.10.2. Preparation of ferric solution

Fe(NH4)2(SO4)2.6H2O (0.2 g) was dissolved in 100 ml 2N HCl and volume was made to 1000 ml with de-ionized water.

3.10.3. Preparation of 2, 2- bipyridine solution

10 g 2,2- bipyridine and 10 ml thioglycolic acid were dissolved in de-ionized water and made the volume 1000 ml.

3.10.4. Procedure

Sample (0.06) g was extracted in 10 ml 0.2N HCl solution in a test tube by shaking for half an hour. Then 1 ml extract was taken in a test tube. 2 ml ferric solution was added into the test tube and covered with a stopper. The test tube was fixed with clip and then heated in a water bath for 30 min. Then test tube was cooled in ice water for 15 min and allowed to adjust at room temperature. 2,2-bipyridine solution (4 ml) was added into the test tube and the contents were mixed. The absorbance was checked at 519 nm by spectrophotometer against de-ionized water after 30-60 sec. The method was calibrated with reference solution as a substitute for the sample solution for each set of analysis.
3.11. Oxalic acid content

The oxalic acid contents were estimated according to the method given by Patil and Gaikwad (2011).

3.11.1. Procedure

For estimation oxalic acid 1g of oven dried powdered bark, 10ml 3N HCl and 65ml of double distilled water were taken in 100ml capacity volumetric flask. The flasks were kept in boiling water bath for 1hr to digest the plant material. After digestion flasks were removed, cooled and diluted up to the mark of 100ml and filtered through Whatman No. 1 filter paper. Two aliquots of 50ml extract were placed in 150ml beakers and 20ml 6N HCl were added in each beaker to increase acidity and avoid pectin retention. The mixture was evaporated to half of its original volume and filtered through Whatman No. 1 filter paper. The precipitate on the filter paper was washed several times with warm double distilled water. To this filtrate 3-4 drops of methyl red indicator (0.01g methyl red in 100ml alcohol) were added and to this concentrated ammonia solution was added until the solution turned faint yellow. After this the solution was heated carefully on water bath maintained at 90° to 100°C, cooled and filtered to remove interfering ferrous ions containing precipitate. The filtrate thus obtained was heated to 90° to 100°C on water bath and to this 10ml 5 percent CaCl₂ was immediately added along with 20 to 25 drops of ammonia solution to restore yellow colour. The solution was kept overnight to settle. On next day, the solution was filtered through ashless filter paper (Whatman Filter Paper No. 44). The precipitate on the filter paper was washed several times with double distilled water to make free from Ca (to check whether the ppt. is free from Ca²⁺ or not, few drops of 5 percent sodium oxalate were added to 3ml of washing filtrate in test tube. Formation of turbidity indicated presence of Ca²⁺ and demanded further washing of ppt). The along with residue the filter paper was dissolved in hot 1:5 H₂SO₄ and this was diluted to 125ml with
double distilled water and transferred to 250ml conical flask. The content of the conical flask was heated at 90\(^\circ\) to 100\(^\circ\)C and titrated against 0.05N KMnO\(_4\). The percentage of oxalate was calculated by using following formula,

\[
\text{ml KMnO}_4 \text{ used } \times 0.05 \times 45.02 \times 100 / 1000 \times \text{dry weight} \times 50/100
\]

3.12. Sensory Evaluation of papad

Prepared garden cress seed papads (raw, fried and toasted) were evaluated for sensory characteristics in terms of appearance, colour, flavour, aftertaste, texture and overall acceptability by 10 semi-trained panel members comprised of academic staff members of the Department of Food Chemistry and Nutrition, College of Food Technology, Parbhani, using 9-point Hedonic scale.

Judgments were made through rating the product on a 9 point Hedonic scale with corresponding descriptive terms ranging from 9 ‘like extremely’ to 1 ‘dislike extremely’. The obtained results were recorded in sensory score card. The format of sensory score card is as given in Appendix I.

3.13. Textural characteristics of gardencress seed papad

Hardness, fracturability, and crispiness of papad were measured by using Stable Micro System TAXT2 plus Texture Analyzer was used for texture profile analysis (TPA). Settings used for the evaluation of papad texture was carried out using a 3-point bending rig (HDP/3PB) and a 5 kg load cell on heavy-duty platform (HDP/90) with test speed of 1 mm/s up to a distance of 3 mm, using trigger force of 5 g, and post-test speed of 10 mm/s. Once the trigger force was attained, the force increased till the time when papad fractured and fell into two pieces. Hardness and fracturability of the sample were measured as a function of maximum force required to break the sample and the sample distance, respectively. The linear distance of the graph can be referred to as crispness of the papad.
Fig 1. Representative graph of Texture Profile Analysis (TPA)

Hardness (kg) = F1
Fracturability (kg) = F2

Where, F1- Positive Peak Force (Cycle 1)
F2- Peak Force (Cycle 1)

3.14. Microbial examination of papad

Microbial examination is the perfect quality assessment protocol performed in food products quality analysis. In the study of microbial quality papad Total Plate Count (TPC), Yeast and Mold were examined for that following procedures were adopted and carried out as per method given by Agrawal et al., (2016).

3.14.1. Total Plate Count (TPC)

The total plate count of papad was determined by using Total Plate Count Agar (Nutrient Agar) containing. The dilutions were made up to 10 to 4 and the 0.1 ml of aliquot was used for the isolation. All process was carried out in a strictly sterile area with the help of Laminar Air Flow. Plates were incubated at
37°C for 48 hrs. and results noted in CFU/ml. Total Plate Count (TPC) of papad was examined on 1 months.

3.14.2. Yeast and Mould

The Yeast and Mould count of papad was determined by using Potato Dextrose Agar (PDA) and the streak plate technique was used for the isolation. The media was sterilized and poured into plates. The dilutions of sample were made up to 10 to 4 and then 0.1 ml of aliquot was used for streaking. Plates were incubated at 37°C for 48 hrs. and results noted in CFU/ml. The Yeast and Mould count of papad was examined on 1 months.

3.15. Determination of computed energy value of prepared products

The energy value were determined by the method of calculation and expressed in kilocalories per 100 g of prepared products. The conversion factor used for protein, carbohydrate and fats were 4, 4 and 9 kcal per g respectively.

3.16. Statistical analysis

The analysis of variance of the data obtained was done by using Completely Randomized Design (CRD) for different treatments as per the method given by Panse and Sukhatme (1967). The analysis of variance revealed at significance of P<0.05 level S.E. and C.D. at 5 per cent level is mentioned wherever required.

3.17. Assessment of cost economics of prepared products

Total cost of prepared products was calculated by considering the current prices of foodstuffs from local market and also the processing cost. The cost was calculated for 1 kg of prepared products.
CHAPTER IV

RESULTS AND DISCUSSION

Present investigation entitled “Studies on effects of gardencress seed (Lepidium sativum L.) incorporation on the quality of black gram (Vigna mungo L.) spiced papad” was carried out in the Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani. The results obtained during present study was presented and discussed. The sincere efforts were made to utilize the gardencress seed powder as a functional ingredient in the formulation of spiced papad. During this investigation the attempt were made to evaluate the sensory characteristics of prepared papad for optimization of suitable incorporation level for preparation of good quality papad. Furthermore, the prepared papad were analyzed for proximate composition for assessment of nutritional quality. Moreover, the effect of addition of gardencress seed powder on the textural qualities of papad were investigated. Beyond that the prepared papad was examined for storage study using different packaging materials.

The results obtained during this investigation are depicted and discussed in the light of relevant information available in the scientific literature under suitable heading and subheadings:

4.1 Physicochemical and mineral composition of Black gram split and Gardencress seed
4.1.2 Physical properties of Black gram split and Gardencress seed
4.1.3 Nutritional composition of Black gram split and Gardencress seed
4.2 Antinutritional properties of Gardencress seed and Black gram split
4.3 Evaluation of colour characteristics of Gardencress seed
4.4 Effect of incorporation of Gardencress seed powder on physical characteristics of papad
4.5 Effect of addition of Gardencress seed powder on sensory characteristics of toasted papad
4.6 Effect of addition of Gardencress seed powder on sensory characteristics of fried papad
4.7 Textural characteristics of Gardencress seed powder papad
4.8 Evaluation of colour characteristics of papad
4.9 Proximate composition of Gardencress powder papad
4.10 Mineral composition of Gardencress seed papad
4.11 Storage study of Gardencress seed papad
4.12 Microbial quality selected Gardencress seed papad
4.13 Theoretical energy value of Gardencress papad
4.14 Theoretical energy value of Gardencress papad
4.1 Physicochemical and mineral composition of Black gram split and Gardencreas seed

4.1.1 Physical properties of Black gram split and Gardencreas seed

Research findings regarding various physical properties of black gram split and gardencreas seed viz., colour, shape, weight of 1000 seeds, true density, bulk density, porosity, length, width, thickness and angle of repose.

Table. 2. Physical parameters of Black gram split and Gardencreas seed

<table>
<thead>
<tr>
<th>Physical Parameters</th>
<th>Black gram split</th>
<th>Gardencreas seed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Value*</td>
<td>Mean Value*</td>
</tr>
<tr>
<td>Colour</td>
<td>Black</td>
<td>Reddish brown</td>
</tr>
<tr>
<td>Shape</td>
<td>Cylindrical</td>
<td>Oval</td>
</tr>
<tr>
<td>Wt. of 1000 seeds (g)</td>
<td>52</td>
<td>1.96</td>
</tr>
<tr>
<td>True Density (kg/m$^3$)</td>
<td>1330</td>
<td>1182</td>
</tr>
<tr>
<td>Bulk density (g/ml)</td>
<td>0.82</td>
<td>0.76</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>39.70</td>
<td>36</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>5.20</td>
<td>2.6</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>4.10</td>
<td>1.2</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>3.54</td>
<td>0.947</td>
</tr>
<tr>
<td>Angle of repose (°)</td>
<td>26°56’</td>
<td>25°17’</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

Presented in table 2 indicates that colour and shape of black gram splits were observed to be black and cylindrical whereas the gardencreas seed were reddish brown and oval in shape. Weight of 1000 seeds, true density, bulk density, porosity and angle of repose of black gram split was reported to be 52g, 1330 kg/m$^3$, 0.82 g/ml, 39.70 percent and 26°56’ degree respectively. The similar results were also reported by Sharon et. al., (2015) for moisture dependent physical properties of black gram.
From table 2 it could be revealed that the weight of 1000 seeds, true density, bulk density, porosity and angle of repose of gardencress seed showed to be 1.96g, 1182 kg/m³, 0.76 g/ml, 36 percent and 25°17’ respectively. The similar results on physical properties of gardencress seed were reported by Gokavi et. al., (2004).

It could be reported that dimensional properties of black gram split like length, width and thickness was found to be 5.20 mm, 4.10 mm, 3.54 mm whereas length, width and thickness of gardencress seed was 2.6 mm, 1.2 mm, and 0.94 mm respectively.

It could be revealed that from table 2 porosity and angle of repose found to be higher in the black gram split i.e., 39.70 percent and 26°56’ whereas in gardencress seed it showed to be 36 percent and 25°17’ respectively. Angle of repose is an indicator of the free flowing nature of seeds and is important in designing the processing equipments. The knowledge of physical properties is important and essential engineering data for storage and processing, size reduction, handling and conveying.

4.1.2. Nutritional composition of Black gram split and Gardencress seed

Data pertaining to Nutritional composition of black gram split and gardencress seed were assessed and findings obtained are depicted in table 3.
Table. 3. Nutritional composition of Black gram split and Gardencress seed

<table>
<thead>
<tr>
<th>Chemical Parameters</th>
<th>Black gram split</th>
<th>Gardencress seed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Value*</td>
<td>Mean Value*</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>10.7 ± 0.01</td>
<td>4.7 ± 0.01</td>
</tr>
<tr>
<td>Crude Fat (%)</td>
<td>1.5 ± 0.02</td>
<td>27.12 ± 0.13</td>
</tr>
<tr>
<td>Crude Protein (%)</td>
<td>23.0 ± 0.21</td>
<td>19.68 ± 0.07</td>
</tr>
<tr>
<td>Total Carbohydrates (%)</td>
<td>59.6 ± 0.12</td>
<td>35.28 ± 0.10</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>3.3 ± 0.6</td>
<td>4.7 ± 0.01</td>
</tr>
<tr>
<td>Crude Fibre (%)</td>
<td>0.7 ± 0.01</td>
<td>6.8 ± 0.03</td>
</tr>
<tr>
<td>Calcium (mg/100g)</td>
<td>138</td>
<td>270</td>
</tr>
<tr>
<td>Phosphorus (mg/100g)</td>
<td>370</td>
<td>520</td>
</tr>
<tr>
<td>Iron (mg/100g)</td>
<td>3.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Potassium (mg/100g)</td>
<td>-</td>
<td>780</td>
</tr>
<tr>
<td>Zinc (mg/100g)</td>
<td>-</td>
<td>4.9</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

The proximate contents of black gram splits like moisture, crude fats, crude protein, carbohydrates, ash, crude fibre, calcium, phosphorus and iron were estimated and it is found to be 10.7 percent, 1.5 percent, 23.0 percent, 59.6 percent, 3.3 percent, 0.7 percent, 138 mg/100g, 370 mg/100g, 3.7 mg/100g respectively. Similar results were reported by Kamboj and Nanda, (2017) for different legumes.

It could be revealed from table 3 the nutritional composition of gardencress seed pretends to have moisture, crude fats, crude protein, carbohydrates, ash, crude fibre, calcium, phosphorus, iron, potassium and zinc were found to be 4.7 percent, 27.12 percent, 19.68 percent, 35.28 percent, 4.7 percent, 6.8 percent, 270 mg/100g, 520 mg/100g, 7.4 mg/100g, 780 mg/100g and 4.9 mg/100g respectively.
Result indicated for nutritional composition of gardencress seed are in line with finding of Yareshimi and Hiremath (2017).

Date from table 3 showed that gardencress seed pretends to have paramount of crude fat, ash and crude fiber as compared to black gram split.

**4.2 Antinutritional properties of Gardencress seed and Black gram split**

Data regarding the antinutritional factors present in gardencress seed and black gram splits were evaluated and results pertaining are depicted in table 4.

**Table 4. Antinutritional factors of Black gram split and Gardencress seed**

<table>
<thead>
<tr>
<th>Antinutritional Factor</th>
<th>Gardencress seed</th>
<th>Black gram split</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean value*</td>
<td>Mean value*</td>
</tr>
<tr>
<td></td>
<td>(mg/100 g)</td>
<td>(mg/100 g)</td>
</tr>
<tr>
<td>Tannin</td>
<td>50.00 ± 2.00</td>
<td>53.5 ± 23</td>
</tr>
<tr>
<td>Phytic Acid</td>
<td>0.75 ± 0.12</td>
<td>64.1 ± 0.16</td>
</tr>
<tr>
<td>Oxalic acid</td>
<td>133.96 ± 1.98</td>
<td>-</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

Antinutritional factors of black gram split and gardencress seed presented in table 4 indicates that tannin content was 50 mg/100g whereas that of black gram split 53.5 mg/100g which was found higher than that of gardencress seed. The phytic acid content was 0.75 mg/100g whereas that of black gram split was 64.1 mg/100g which indicates that black gram split contain more phytic acid as compared to gardencress seed. The oxalic acid content of gardencress seed was 133.96 mg/100g whereas no such oxalic acid content was found in black gram split which indicates that black gram does not content any oxalic acid.

Similar results were reported by Agrawal and Sharma, (2013) for the finding of tannin, phytic acid and oxalic acid in gardencress seed.

Resulted reported for tannin and phytic acid content of black gram split are good agreement with finding of Jain et. al., (2009).

Tannin is known to form complexes with proteins which is responsible for low protein digestibility, decreased amino acids availability. Phytate is responsible
for mineral bioavailability (Jain et. al., 2009). According to Agrawal and Sharma, (2013) oxalates are antinutrients which affect bioavailability of essential nutrients in plant foods.

4.3 Evaluation of colour characteristics of gardencress seed

Data pertaining to the colour characteristics of raw gardencress seed and gardencress seed powder were determined and results are presented in table 5.

Table. 5. Colour characteristics of raw and roasted gardencress seed powder.

<table>
<thead>
<tr>
<th>Sample</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>C</th>
<th>Hue (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw GCSP</td>
<td>59.20</td>
<td>8.03</td>
<td>26.25</td>
<td>27.47</td>
<td>73.01</td>
</tr>
<tr>
<td>Roasted GCSP</td>
<td>34.54</td>
<td>11.76</td>
<td>20.95</td>
<td>24.07</td>
<td>60.74</td>
</tr>
</tbody>
</table>

Where, GCSP- Gardencress seed powder

Data presented in table 5 indicates colour properties of raw and roasted gardencress seed powder were determined by considering L*, a*, b*, chroma, and hue values. It could be revealed that the lightness value (L*) for raw GCSP was 59.20 whereas that of roasted GCSP 34.54 which was lower than that of raw gardencress seed powder.

Results for a* value observed for raw and roasted GCSP was found to be 8.03 to 11.76 respectively. a* value for raw GCSP was considerably lower than roasted GCSP. A* value represents the greenness and redness component of the sample.

It can be observed that value for b* represents the blueness and yellowness colour components of sample. The results showed that the b* value for raw GCSP was higher compared to roasted GCSP sample were 26.25 and 20.95 observed respectively.

Data from table 5 shown that the colour value in terms of chroma and hue was noticed to decrease after roasting of gardencress seed. The chroma value for roasted GCSP (24.07°) was profoundly lower compared to raw (27.47°).
Moreover, there was vast difference in hue value of raw and roasted powder were observed to be 73.01 to 60.74 respectively.

Colour characteristics is an important to decide the acceptability and quality of final product. The colour properties of raw and toasted papad were determined using Colorflex EZ colorimeter by considering the L, a, b, chroma and hue values.

4.4 Effect of incorporation of garden cress seed powder on physical characteristics of papad.

Date pertaining to the physical properties of papad sample were investigated for thickness, diameter expansion ratio and increase in weight and are presented in table 6.

**Table 6. Physical properties of papad incorporated with garden cress seed powder**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Thickness (mm)</th>
<th>Diameter</th>
<th>Expansion Ratio (%)</th>
<th>Weight of Papad</th>
<th>Increase in weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before Frying (mm)</td>
<td>After Frying (mm)</td>
<td>Before Frying (g)</td>
<td>After Frying (g)</td>
</tr>
<tr>
<td>T0</td>
<td>0.059</td>
<td>110.14</td>
<td>115.58</td>
<td>4.93</td>
<td>6.41</td>
</tr>
<tr>
<td>T1</td>
<td>0.056</td>
<td>112.44</td>
<td>117.72</td>
<td>4.69</td>
<td>7.81</td>
</tr>
<tr>
<td>T2</td>
<td>0.062</td>
<td>113.93</td>
<td>118.85</td>
<td>4.31</td>
<td>7.75</td>
</tr>
<tr>
<td>T3</td>
<td>0.058</td>
<td>114.64</td>
<td>120.87</td>
<td>5.38</td>
<td>7.90</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

Where, T0-(100:00), T1-(90:10), T2-(80:20) and T3-(70:30)

It could be revealed that the mean value for thickness of papad was observed to be 0.059 for T0, 0.056 for T1, 0.062 for T2 and 0.058 mm for T3 respectively.

Results reported for diameter of papad before and after frying were investigated and results for diameter of papad before frying showed to be 110.14
for T0, 112.44 for T1, 113.93 for T2 and 114.64 mm for T3. Whereas, results indicated for diameter of papad after frying for T0, T1, T2 and T3 were 115.58, 117.72, 118.85 and 120.87 mm respectively.

![Graph showing diameter of papad before and after frying](image)

**Fig. 2. Diameter of papad before and after frying**

Further, prepared papad were evaluated for expansion ratio and mean value for sample T0, T1, T2 and T3 were observed to be 4.93, 4.69, 4.31 and 5.38 percent accordingly. Moreover, results regarding weight of papad before and after frying were examined. The values for weight of papad before frying with respect to sample T0, T1, T2 and T3 were recorded to be 6.41, 7.81, 7.75 and 7.90 g respectively. Although, average value for weight of papad after frying were noticed that sample T0 showed 7.20g, T1 8.93g, T2 9.49g and T3 had 8.94 g respectively.
Graph. 3. Expansion ratio of papad

It can be observed from table 6 that increase in weight of papad for sample T0 was found to be 12.32 percent, sample T1 had 14.34 percent, sample T2 22.45 percent whereas sample T3 reported to have 13.16 percent.

Data from above table 6 showed that there was increase in weight of papad after frying was noticed in case of all the samples. In addition to increase in percent weight of papad was observed for sample T0, T1 and T2 whereas sample T3 reported least value for weight. Results reported for physical properties of papad are more or less similar to the finding of Chavan et. al., (2015)

It can be clearly shown that expansion ratio of papad were varied significantly and showed increasing trend in results. The effect on expansion ratio of papad may be affected due to frying condition on diametrical expansion of papad. It can be said that increase in frying time is directly related to expansion ratio may be attributed due to vaporization of water and development of air spores and uptake of oil. Math et. al., (2004)

4.5 Effect of addition of garden cress seed powder on sensory characteristics of toasted papad

Data pertaining to the various sensory attributes of toasted papad were taken into consideration includes appearance, colour, flavour, after taste, texture
and overall acceptability were determined by using 9 point hedonic scale the data generated are given in table 7 and fig 4.

Table 7. Sensory evaluation of different formulation of toasted papad

<table>
<thead>
<tr>
<th>Samples</th>
<th>Appearance</th>
<th>Colour</th>
<th>Flavour</th>
<th>After Taste</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>8.7</td>
<td>9.0</td>
<td>8.5</td>
<td>9.0</td>
<td>9.0</td>
<td>8.8</td>
</tr>
<tr>
<td>T1</td>
<td>8.5</td>
<td>8.7</td>
<td>8.5</td>
<td>9.0</td>
<td>8.5</td>
<td>8.6</td>
</tr>
<tr>
<td>T2</td>
<td>7.5</td>
<td>8.0</td>
<td>8.0</td>
<td>8.5</td>
<td>8.5</td>
<td>8.1</td>
</tr>
<tr>
<td>T3</td>
<td>7.0</td>
<td>7.0</td>
<td>7.5</td>
<td>7.5</td>
<td>8.0</td>
<td>7.4</td>
</tr>
<tr>
<td>SE ±</td>
<td>0.154</td>
<td>0.152</td>
<td>0.179</td>
<td>0.114</td>
<td>0.218</td>
<td>0.114</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.453</td>
<td>0.446</td>
<td>0.525</td>
<td>0.336</td>
<td>0.642</td>
<td>0.336</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

Where, T0-(100:00), T1-(90:10), T2-(80:20) and T3-(70:30).

Results given in table 7 showed that sensory evaluation of toasted papad prepared with addition of different level of gardencress seed powder viz., 10, 20 and 30 percent respectively. The sensory score for appearance recorded for sample T0 were 8.7, T1 8.5, T2 7.5 whereas sample T3 received 7.0. Furthermore, colour of toasted papad were evaluated and mean values shown for sample T0, T1, T2 and T3 were 9.0, 8.7, 8.0 and 7.0 respectively.

It could be observed that flavour score of toasted papad samples were varied and values reported to be 8.5, 8.5, 8.0 and 7.5 for corresponding samples T0, T1, T2 and T3. Additionally, sensory score given for after taste was 9.0 for sample T0, 9.0 for sample T1, 8.5 for sample T2 and sample T3 recorded 7.5.

Furthermore, sensory score assigned for texture of toasted papad were found to be 9.0, 8.5, 8.5 and 8.0 for respective sample T0, T1, T2 and T3. Results revealed for overall acceptability of toasted papad were determined by considering mean score of all sensory attributes. The mean value for overall acceptability were observed to be 8.8, 8.6, 8.1 and 7.4 with respect to sample T0, T1, T2 and T3.
Finally it could concluded that the overall acceptability of toasted papad sample were varied distinctly for different samples. The maximum overall acceptability score were recorded by sample T0 (8.8) followed by T1 (8.6) whereas, sample T2 and T3 reported lowest values i.e., 8.1 and 7.4 respectively. The deviation in the overall acceptability score of toasted papad may be due to addition level of gardencress seed powder. Overall, it can be revealed that the sensory evaluation of toasted papad made by incorporation of 10 percent gardencress seed powder were organoleptically acceptable. However, it was noticed that when the level of gardencress seed powder increased beyond acceptable level in papad the mean score for organoleptic evaluation in terms of appearance, colour, flavour, after taste and texture were found to be decreased. The finding of present study are good in accordance with the result reported by Kaur and Sharma (2015).

The decrease in overall sensory acceptability of toasted papad may be associated with incorporation level of gardencress seed powder which imparts bitterness effect to papad. As, gardencress seed contains alkaloids and glucosides might be responsible for bitterness as reported by Sarkar et. al., (2014).
4.6 Effect of addition of gardencress seed powder on sensory characteristics of fried papad

The sensory attributes of fried papad taken into consideration consists appearance, colour, flavour, after taste, texture and overall acceptability. The data regarding sensory properties of fried papad are summarized in table 8 and fig 5.

Table 8. Sensory evaluation of different formulation of fried papad

<table>
<thead>
<tr>
<th>Samples</th>
<th>Appearance</th>
<th>Colour</th>
<th>Flavour</th>
<th>After Taste</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>8.8</td>
<td>9.0</td>
<td>8.7</td>
<td>9.0</td>
<td>9.0</td>
<td>8.9</td>
</tr>
<tr>
<td>T1</td>
<td>8.6</td>
<td>8.4</td>
<td>8.5</td>
<td>9.0</td>
<td>8.5</td>
<td>8.6</td>
</tr>
<tr>
<td>T2</td>
<td>7.2</td>
<td>8.3</td>
<td>8.1</td>
<td>8.2</td>
<td>8.5</td>
<td>8.0</td>
</tr>
<tr>
<td>T3</td>
<td>6.9</td>
<td>7.1</td>
<td>7.1</td>
<td>7.2</td>
<td>7.9</td>
<td>7.2</td>
</tr>
<tr>
<td>SE ±</td>
<td>0.040</td>
<td>0.056</td>
<td>0.103</td>
<td>0.084</td>
<td>0.066</td>
<td>0.128</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.119</td>
<td>0.165</td>
<td>0.303</td>
<td>0.246</td>
<td>0.195</td>
<td>0.377</td>
</tr>
</tbody>
</table>

*Each value is average of three determinations

Where, T0-(100:00), T1-(90:10), T2-(80:20) and T3-(70:30).

Results given in table 8 showed that sensory evaluation of fried papad prepared with addition of different level of gardencress seed powder viz., 10, 20 and 30 percent respectively. The sensory score for appearance recorded for sample T0 were 8.0, T1 8.6, T2 7.2 whereas sample T3 received 6.9. Furthermore, colour of toasted papad were evaluated and mean values shown for sample T0, T1, T2 and T3 were 9.0, 8.4, 8.3 and 7.1 respectively.

It could be observed that flavour score of fried papad samples were varied and values reported to be 8.7, 8.5, 8.1 and 7.1 for corresponding samples T0, T1, T2 and T3. Additionally, sensory score given for after taste was 9.0 for sample T0, 9.0 for sample T1, 8.2 for sample T2 and sample T3 recorded 7.2.

Furthermore, sensory score assigned for texture of fried papad were found to be 9.0, 8.5, 8.5 and 7.9 for respective sample T0, T1, T2 and T3. Results
revealed for overall acceptability of toasted papad were determined by considering mean score of all sensory attributes. The mean value for overall acceptability were observed to be 8.9, 8.6, 8.0 and 7.2 with respect to sample T0, T1, T2 and T3.

**Fig 5. Sensory evaluation of fried papad**

Finally it could concluded that the overall acceptability of fried papad sample were varied distinctly for different samples. The maximum overall acceptability score were recorded by sample T0 (8.9) followed by T1 (8.6) whereas, sample T2 and T3 reported lowest values i.e., 8.0 and 7.2 respectively. The deviation in the overall acceptability score of fried papad may be due to addition level of gardencress seed powder. Overall, it can be revealed that the sensory evaluation of fried papad made by incorporation of 10 percent gardencress seed powder were organoleptically acceptable. However, it was noticed that when the level of gardencress seed powder increased beyond acceptable level in papad the mean score for organoleptic evaluation in terms of appearance, colour, flavour, after taste and texture were found to be decreased. The finding of present study are good in accordance with the result reported by Kaur and Sharma (2015).

It could concluded that decrease in overall acceptability of fried papad may be attributed to incorporation level of gardencress seed powder which has direct
impact on overall sensory score due to its properties that contributes bitter taste and also decreases the colour value of product.

4.7 Textural characteristics of gardencress seed powder papad

In this experiment, the textural analysis were performed to determine the textural properties of papad incorporated with gardencress seed powder with respect to hardness and fracturability were investigated and results pertaining are depicted in Table 9.

Table 9. Influence of gardencress seed powder on textural properties of papad

<table>
<thead>
<tr>
<th>Sample</th>
<th>Textural properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hardness (g)</td>
</tr>
<tr>
<td>T0</td>
<td>Raw</td>
</tr>
<tr>
<td></td>
<td>Toasted</td>
</tr>
<tr>
<td></td>
<td>Fried</td>
</tr>
<tr>
<td>T1</td>
<td>Raw</td>
</tr>
<tr>
<td></td>
<td>Toasted</td>
</tr>
<tr>
<td></td>
<td>Fried</td>
</tr>
<tr>
<td></td>
<td>SE ±</td>
</tr>
<tr>
<td></td>
<td>CD at 5%</td>
</tr>
</tbody>
</table>

Where, T0 (100:00) and T1 (90:10).

Data from Table 9 indicates that hardness of control samples T0 was reported to be 158, 381 and 324 g for raw, toasted and fried respectively. Whereas the hardness of selected sample (T1) of papad were 258, 341 and 330g respectively with respect to raw, toasted and fried samples.

Furthermore, facturability of control sample T0 was indicated to be 158 g for raw papad sample, 267 g for toasted papad and 324 g for fried papad respectively followed by sample T1 which showed that 258 g, 215 g and 193 g for raw, toasted and fried papad.
It could be revealed from table 9 that there was gradual increase in the hardness value for raw T1 sample as compared to T0. Hardness of control toasted sample T0 was more compared to T1 toasted sample. Whereas hardness of control fried sample T0 found to be higher than that of sample T1.

Similarly, results for fracturability of papad revealed that raw T0 sample had lowest value than raw T1 papad. In case of toasted T0 sample fracturability values were found to be decreased in T1 toasted sample. Whereas T0 fried sample shows higher fracturability than that of T1. Similar results of textural properties of papad were reported by Senthil et. al., (2006)

4.8 Evaluation of colour characteristics of papad

The colour properties of raw and toasted papad were determined using Colorflex EZ colorimeter by considering the L*, a*, b*, chroma and hue (°) values. Data pertaining to the colour characteristics of raw and toasted papad containing different proportion of gardencress seed powder were determined and results are presented in table 10 and fig. 10.
Table 10. Effect of garden cress seed powder addition on colour characteristics of papad

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sample</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>C</th>
<th>Hue (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw papad</td>
<td>62.69</td>
<td>2.30</td>
<td>27.01</td>
<td>27.11</td>
<td>85.13</td>
</tr>
<tr>
<td>T0</td>
<td>Toasted Papad</td>
<td>79.81</td>
<td>2.22</td>
<td>29.54</td>
<td>29.62</td>
<td>85.70</td>
</tr>
<tr>
<td>T1</td>
<td>Raw papad</td>
<td>43.14</td>
<td>1.93</td>
<td>23.18</td>
<td>23.27</td>
<td>85.24</td>
</tr>
<tr>
<td></td>
<td>Toasted Papad</td>
<td>66.96</td>
<td>0.87</td>
<td>35.49</td>
<td>35.50</td>
<td>88.59</td>
</tr>
<tr>
<td>T2</td>
<td>Raw papad</td>
<td>39.22</td>
<td>5.96</td>
<td>19.87</td>
<td>20.74</td>
<td>73.28</td>
</tr>
<tr>
<td></td>
<td>Toasted Papad</td>
<td>59.11</td>
<td>3.37</td>
<td>32.92</td>
<td>33.09</td>
<td>84.14</td>
</tr>
<tr>
<td>T3</td>
<td>Raw papad</td>
<td>35.96</td>
<td>8.01</td>
<td>16.57</td>
<td>18.40</td>
<td>64.10</td>
</tr>
<tr>
<td></td>
<td>Toasted Papad</td>
<td>40.35</td>
<td>5.81</td>
<td>24.57</td>
<td>25.26</td>
<td>76.66</td>
</tr>
</tbody>
</table>

| SE +      | 0.008         | 0.006  | 0.003  | 0.073 | 0.014 |
| CD at 5%  | 0.023         | 0.019  | 0.011  | 0.215 | 0.043 |

Where, T0-(100:00), T1-(90:10), T2-(80:20) and T3-(70:30).

Data presented in table 10 revealed that lightness value (L*) for raw and toasted papad for T0, T1, T2 and T3 were reported to be 62.69 and 79.81, 43.14 and 66.96, 39.22 and 59.11 for sample T3 it was noted to be 35.96 and 40.35 respectively.
Results for $a^*$ value observed to be raw and toasted papad for sample T0, T1, T2 and T3 were found to be 2.30 and 2.22, 1.93 and 0.87, 5.96 and 3.37 for sample T3 it was showed 8.01 and 5.81.

It can be observe that value for $b^*$ represents the blueness and yellowness colour components of sample. The results showed that the $b^*$ value for raw and toasted papad for T0, T1, T2 and T3 noticed to be 27.01 and 29.54, 23.18 and 35.49, 19.87 and 32.92 whereas as for sample T3 it was showed that 16.57 and 24.57 respectively.

![Fig. 10. Colour characteristics of papad](image)

Data from table 10 chroma values were observed to be raw and toasted papad for T0, T1, T2 and T3 were observed to be 27.11 and 29.62, 23.27 and 35.50, 20.74 and 33.09 whereas for T3 sample 18.40 and 25.26 respectively.

Furthermore, hue values for raw and toasted papad for sample T0, T1, T2 and T3 showed 85.13° and 85.70°, 85.24° and 88.59°, 73.28° and 84.14° whereas for T3 it was observed to be 64.10° and 76.66°.

It was noticed that the colour value was significantly decreased with increase in level of garden cress seed powder for all the samples.
4.9 Proximate composition of gardencress seed powder papad

Data pertaining to various chemical properties of papad prepared with addition of various level of gardencress seed powder were determined and results obtained are illustrated in table 11 and fig. 11.

Table 11. Proximate composition of papad prepared with addition of gardencress seed powder

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Carbohydrates (%)</th>
<th>Ash (%)</th>
<th>Fiber (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>5.80</td>
<td>5.34</td>
<td>18.65</td>
<td>56.32</td>
<td>7.37</td>
<td>0.5</td>
</tr>
<tr>
<td>T1</td>
<td>5.10</td>
<td>6.16</td>
<td>20.81</td>
<td>58.60</td>
<td>6.28</td>
<td>1.19</td>
</tr>
<tr>
<td>T2</td>
<td>4.72</td>
<td>7.28</td>
<td>22.12</td>
<td>60.12</td>
<td>6.71</td>
<td>1.81</td>
</tr>
<tr>
<td>T3</td>
<td>4.53</td>
<td>7.97</td>
<td>22.93</td>
<td>61.41</td>
<td>7.16</td>
<td>2.18</td>
</tr>
<tr>
<td>SE ±</td>
<td>0.046</td>
<td>0.015</td>
<td>0.018</td>
<td>0.004</td>
<td>0.007</td>
<td>0.033</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.135</td>
<td>0.046</td>
<td>0.053</td>
<td>0.013</td>
<td>0.022</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Where, T0-(100:00), T1-(90:10), T2-(80:20) and T3-(70:30)

It can be observed that the average values for moisture content for different samples such as T0, T1, T2 and T3 was 5.80, 5.10, 4.72 and 4.53 percent respectively. Results reported for fat content of papad for sample T0, T1, T2 and T3 were 5.34, 6.16, 7.28 and 7.97 percent. Whereas the protein content of papad were noted to be 18.65, 20.81, 22.12 and 22.93 respectively for sample T0, T1, T2 and T3.

Results revealed that carbohydrate content of papad varied for sample T0, T1, T2 and T3 were 56.32, 58.60, 60.12 and 61.41 percent respectively. Furthermore, ash content were reported to be 7.37, 6.28, 6.21 and 7.16 percent for sample T0, T1, T2 and T3. Also, fiber content of papad were analyzed and results found that sample T0 had 0.5 percent fiber, T1 1.19 percent, T2 1.81 percent whereas for sample T3 fiber content was 2.18 percent.
Fig. 11. Chemical composition of gardencress papad

Results in above table 11 revealed that the carbohydrates was found to be increased significantly with addition of gardencress see powder in papad samples. Hence, the highest amount of carbohydrates in papad indicates the presence of appreciable amount of carbohydrates and fiber in gardencress seed. The higher protein and lipid content indicates that gardencress seed have high food energy. It was also observed that increase in ash content clearly indicates that good source of minerals (Singh et. al., 2015).

Results for chemical composition of papad were more or less similar with finding reported by Agrawal et. al., (2016).

4.10 Mineral composition of gardencress seed papad

Data related to different mineral content of T0 and T1 samples of papad like calcium, phosphorus, potassium, iron and zinc were analyzed and results are summarized in table 12.
Table 12. Mineral composition of papad added with gardencress seed powder

<table>
<thead>
<tr>
<th>Minerals</th>
<th>T0</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Value*</td>
<td>Mean Value*</td>
</tr>
<tr>
<td></td>
<td>(mg/100g)</td>
<td>(mg/100g)</td>
</tr>
<tr>
<td>Calcium</td>
<td>123</td>
<td>155</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>328</td>
<td>381</td>
</tr>
<tr>
<td>Iron</td>
<td>3.2</td>
<td>4.44</td>
</tr>
<tr>
<td>Potassium</td>
<td>-</td>
<td>782</td>
</tr>
<tr>
<td>Zinc</td>
<td>-</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Where, T0-100:00 and T1-90:10

It was observed from table 12 that mean value for calcium, phosphorus and iron content in T0 sample were reported to be 123, 328 and 3.2 mg/100g respectively. Whereas, there was no potassium and zinc content was observed in T0 sample.

Similarly, mean values for mineral content of sample T1 with respect to calcium, phosphorus, iron, potassium and zinc were observed to be 155, 381, 4.44, 728 and 0.48 mg/100g respectively.

It can be clearly revealed from table 12 that mineral composition of papad incorporated with gardencress seed powder were found to be comparatively higher than that of T0 sample.

Finding for mineral composition are in accordance with results of Veena et.al., (2012).

4.5 Storage study of gardencress seed powder papad

It is important to determine the storage study of final product to assess its shelf life and consumer acceptability. The prepare papad were subjected for storage study with respect to different packaging material such as HDPE, Steel
box and aluminium foil pouches for varied storage period for 120 days at ambient temperature and were evaluated with respect to moisture, texture and flavour of papad were investigated.

Results obtained are quoted in table 13.

**Table 13. Influence of packaging material and storage period on qualities of papad (at ambient temperature)**

<table>
<thead>
<tr>
<th>Period of storage (days)</th>
<th>Papad sample</th>
<th>Sensory Evaluation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moisture content (%)</td>
<td>Texture</td>
</tr>
<tr>
<td>0</td>
<td>HDPE</td>
<td>5.10</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.10</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.10</td>
<td>Crisp</td>
</tr>
<tr>
<td>15</td>
<td>HDPE</td>
<td>5.12</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.16</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.11</td>
<td>Crisp</td>
</tr>
<tr>
<td>30</td>
<td>HDPE</td>
<td>5.14</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.19</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.12</td>
<td>Crisp</td>
</tr>
<tr>
<td>60</td>
<td>HDPE</td>
<td>5.15</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.20</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.14</td>
<td>Crisp</td>
</tr>
<tr>
<td>90</td>
<td>HDPE</td>
<td>5.15</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.23</td>
<td>Less Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.16</td>
<td>Crisp</td>
</tr>
<tr>
<td>120</td>
<td>HDPE</td>
<td>5.21</td>
<td>Crisp</td>
</tr>
<tr>
<td></td>
<td>Steel Box</td>
<td>5.28</td>
<td>Less Crisp</td>
</tr>
<tr>
<td></td>
<td>Aluminium foil pouches</td>
<td>5.26</td>
<td>Crisp</td>
</tr>
</tbody>
</table>
It can be observed from table 13 revealed that effect of storage period and different packaging material on moisture content, texture and flavour were investigated upto 120 days storage period at ambient temperature. It was showed that there was no remarkable change in the moisture content was observed during course of storage period in case of all the packaging material and samples. The value of moisture content were ranged from 5.10 to 5.28 percent, there was negligible difference in the moisture content of papad throughout the storage period.

Flavour is main criteria that makes the product to be liked or disliked. The perception of flavour is a combination of taste, smell, impression and texture (Chavan et. al., 2015). Data from table 13 revealed that effect of storage period and packaging material on texture and flavour of papad was assessed during 120 days storage showed that there was no remarkable changes in texture and flavour upto 90 days. Crispiness is the frying quality which shows rheological characteristics of the product during sensory evaluation by mouth feel. It was reported that papad lose their crispiness after a period of 90 days and decreases as storage period advances.

Overall it could be revealed that the papad packaged in aluminium foil pouches can be stored safely for a period of 120 days followed by HDPE.

4.5 Microbial quality selected gardencress seed powder papad

The papad prepared with addition of gardencress seed powder were analyzed for microbial qualities with respect to yeast and mould and total plate count. The results recorded during this investigation are presented in table 14.

**Table 14. Microbial properties of papad**

<table>
<thead>
<tr>
<th>Yeast and mould (cfu/g)</th>
<th>Total plate count (cfu/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.7 \times 10^2$</td>
<td>$1.2 \times 10^2$</td>
</tr>
</tbody>
</table>
It was clearly noticed from table 14 that the yeast and mould was found to be $1.7 \times 10^2$ cfu/g whereas the total plate count was observed to $1.2 \times 10^2$ cfu/g. The microbial analysis done for selected papad were in close as reported by Agrawal et. al., (2016).

4.11 Theoretical energy value of garden cress papad

It is important to understand the energy value of foods to predict its nutritional quality. The theoretical energy value of selected papad were calculated on the basis of chemical composition of papad comprises carbohydrates, fats and protein by multiplying with factor 4 for carbohydrate and protein and by 9 for fat to determine the total energy value of product. The data regarding the nutritive value of garden cress seed papad is given in table 15.

Table 15. Energy value of different formulation of papad

<table>
<thead>
<tr>
<th>Sample</th>
<th>Chemical components</th>
<th>Total energy values (Kcal/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fat (Kcal)</td>
<td>Protein (Kcal)</td>
</tr>
<tr>
<td>T0</td>
<td>48.06</td>
<td>74.60</td>
</tr>
<tr>
<td>T1</td>
<td>55.44</td>
<td>83.24</td>
</tr>
<tr>
<td>T2</td>
<td>65.52</td>
<td>88.48</td>
</tr>
<tr>
<td>T3</td>
<td>71.93</td>
<td>91.72</td>
</tr>
</tbody>
</table>

Where, T0 (100:00), T1 (90:10), T2 (80:20) and T3 (70:30).

It can be revealed from the table 15 that total energy value obtained for T0, T1, T2 and T3 were 347.94, 373.08, 394.48 and 421.23 Kcal/100g respectively. The highest energy value was reported by sample T3 i.e. 421.23 Kcal/100g compared to control and other samples.
The deviation in the total energy value of papad was mainly due to variation in the chemical composition of papad samples. As indicated that sample T3 contained 30 percent gardencress seed had higher energy value as compared to control and other samples. The energy value was shown to increase with increase in supplementation of gardencress seed powder in papad respectively. As gardencress seed is potential source of carbohydrate, proteins, and lipids indicates good source of energy (Singh et. al., 2015).

4.5 Technoeconomical feasibility of gardencress seed powder papad

In order to justify commercial exploitation of product, it is necessary to determine technoeconomical feasibility for production of papad. Dew efforts were taken to access to costing for preparation of papad. Average cost was discussed as per market prices of ingredients in Parbhani region. However, it was learnt that bulk purchasing in higher quantities may reduce the total cost of production.
beyond calculated values. The data pertaining to cost analysis for preparation of
garden cress seed papad is presented in table 16.

**Table 16. Cost of production of garden cress papad.**

<table>
<thead>
<tr>
<th>Particular</th>
<th>Quantity used</th>
<th>Unit price (Rs.)</th>
<th>Cost (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black gram</td>
<td>900 g</td>
<td>60</td>
<td>54.00</td>
</tr>
<tr>
<td>Garden cress seed</td>
<td>100 g</td>
<td>320</td>
<td>32.00</td>
</tr>
<tr>
<td>Edible oil</td>
<td>150 ml</td>
<td>80</td>
<td>12.00</td>
</tr>
<tr>
<td>Mixed spices</td>
<td>60 g</td>
<td>480</td>
<td>28.80</td>
</tr>
<tr>
<td><strong>Total Raw material cost (Rs.)</strong></td>
<td></td>
<td></td>
<td><strong>126.80</strong></td>
</tr>
<tr>
<td>Processing and packaging cost @ 15% of raw material cost (Rs.)</td>
<td></td>
<td></td>
<td><strong>19.02</strong></td>
</tr>
<tr>
<td><strong>Production cost for papad for 1 kg (Rs.)</strong></td>
<td></td>
<td></td>
<td><strong>145.82</strong></td>
</tr>
<tr>
<td><strong>Production cost for 10 kg (Rs.)</strong></td>
<td></td>
<td></td>
<td><strong>1458.2</strong></td>
</tr>
</tbody>
</table>

It was examined from data given in table 16 that cost of production for preparation of papad with incorporation of garden cress seed powder were investigated. It was observed that total cost required for production of 1 kg papad including processing and packaging cost at 15 percent of raw material cost was calculated to be 145.82 rupees whereas cost for production of 10 kg papad were 1458.2 rupees. The cost calculated for bulk production can give idea about commercial exploitation of product.
CHAPTER V

SUMMARY AND CONCLUSION

The present study entitled “Studies on effects of gardencress seed (Lepidium sativum L.) incorporation on the quality of black gram (Vigna mungo L.) spiced papad” has been undertaken to exploit the garden cress seed in formulation of papad as a functional ingredient by keeping in view the nutritional value of garden cress seed. The results obtained throughout the entire investigation are summarized as follows.

Garden cress seed is highly nutritious and it is good source of proteins, fat, dietary fibers, calcium, phosphorus and iron which make it as indigenous source of nutrient with this comprehensive research is mainly focused on supplementation of garden cress seed in preparation of papad. Therefore, the sincere efforts have been made to use garden cress seed in formulation of papad.

The efforts were taken to standardize the formulation for development of papad with variation in the proportion of garden cress seed powder supplementation with black gram flour viz., 0:100, 10:90, 20:80 and 30:70 respectively.

Results of physical properties of black gram seed observed that weight of 1000 seeds, true density, bulk density, porosity and angle of repose were reported to be 52g, 1330 kg/ m³, 0.82 g/ml 39.70 percent and 26.56 degree respectively. Additionally the chemical properties of black gram have been studied and showed maximum amount carbohydrates i.e. 57.06 percent followed by proteins 23.7 percent can be assumed to have good source of energy also mean value of moisture, fat, ash and crude fiber were estimated to 10.7 percent, 1.5 percent, 3.3 percent and 0.7 percent respectively.

The efforts were also made to assess the minerals in black gram seed calcium, phosphorus and iron content were shown to be 138, 370 and 3.7 mg/100g
respectively as well as highest amount of phosphorus was noted (370 mg/100g) followed by calcium (138 mg/100g) on the other hand least amount of iron content was shown (3.7 mg/100g).

Sincere efforts were also taken to characterize the physical properties, chemical and mineral composition of garden cress seed results showed for dimensional properties like length, width and thickness was 2.6 mm, 1.2 mm, and 0.94 mm respectively. Also the weight of 1000 seeds was noticed to be 1.96 g, true density was 1182 kg/m³ and bulk density was found to be 0.76 g/ml and angle of repose was 25°17’.

It is clearly shown that garden cress have highest amount of carbohydrates and fat content were 35.28 percent and 27.12 percent respectively in garden cress seed. The fat content in garden cress seed was more as compared to black gram splits. Along with garden cress seed shown to have good source of dietary fibers contained 6.8 percent which was highest than black gram splits. The value for protein content comprise 19.68 percent whereas the ash content were 4.7 percent. In contrast to garden cress seed the protein content was noticed to be greater in black gram splits.

Additionally, the value for minerals in garden cress have been assessed result indicate that calcium, phosphorus, potassium, iron and zinc were observed to be 270, 520, 780, 7.4 and 4.9 mg/100g respectively. In short Garden cress seed is a good source of minerals. Garden cress seed had appreciably greater amount of minerals like phosphorus, calcium, potassium and iron as compared with black gram splits.

Study have been also done to assess the Antinutritional factors present in garden cress seed revealed substantial amount of oxalic acid was reported i.e. 133.96 mg/100g followed by tannins 50 mg/100g. While, phytic acid had present in least amount i.e. 0.75 mg/100g.
The attempt have been made to study the colour properties of raw and roasted garden cress seed powder were determined. The results shows $L^*$ value indicates the lightness or darkness of sample. The value reported for lightness of raw GCSP and roasted GCSP were 59.20 and 34.54 respectively. Results for $a^*$ value for raw and roasted GCSP was found to be 8.03 to 11.76 respectively. Results for $b^*$ value for raw GCSP was higher compared to roasted GCSP sample were 26.25 and 20.95 observed respectively. The chroma value for roasted GCSP ($24.07^0$) was profoundly lower compared to raw ($27.47^0$). Moreover, there was vast difference in hue value of raw and roasted powder were observed to be 73.01 to 60.74 respectively.

Intention have been also focused to study the effect of garden cress seed powder addition on physical properties of papad. It is noticed that the colour of sample T0 was observed to be yellowish while T1 had light brown in colour. Moreover, the colour of sample T2 and T3 were affected remarkably. The colour of sample T0 and T1 was highly acceptable over rest of the samples. The diameter of papad before frying were ranged from 110.14 to 114.64 mm respectively whereas diameter after frying was ranged from 115.58 to 120.87 mm. It was clearly observed that the diameter of papad was noticed to increase after frying, for instance the diameter of sample T2 before frying was 113.93 mm which was shown to increase 118.85 mm after frying also expansion ratio of papad were ranged from 4.31 to 5.38 percent. There was notably slight variation in weight of papad after frying has been observed.

Overall it is clearly shown from the sensory evaluation of toasted papad concluded that sample T1 was found to be superior in case of all the sensory attributes and scored 8.6 for overall acceptability which contained 10 percent garden cress seed powder followed by T2 (8.1) contained 20 percent garden cress seed powder. Beyond 20 percent level the overall acceptability score was reported to be decreased and showed negative impact on sensory qualities.
The study have stressed to determine the sensory properties of fried papad which concluded that sample T1 scored 8.6 and declared excellent by panelists followed by T2 achieved 8.0. Hence, suggested that garden cress seed powder can be incorporated upto 20 percent level above that level sensory qualities was reported to be affected especially in case of colour and after taste.

Intention has been given to characterize the textural properties of prepared papad. It is shown that hardness of control samples was reported to be 158, 381 and 324 g for raw, toasted and fried respectively. The maximum hardness value attained by toasted T1 sample was 341g followed by fried 330g respectively whereas the least hardness was noticed in case of T1 raw sample. Statistically there was significant deviation in hardness results.

The efforts have been taken to determine the colour properties of papad. Results indicates that highest lightness value was observed in case of sample T0 (65.69) followed by T1 (43.14) compared to rest of the samples whereas a* value for toasted sample showed deviation in results were ranged from 0.87 to 5.81 accordingly. It is clearly found that all the colour parameters were significantly affected with respect to addition of garden cress seed powder in papad.

Obviously efforts made to analyze the proximate composition of papad which reported that moisture content ranged from 4.53 to 5.80 percent. The fat content of papad reflect the vast majority in results were distinguished from 5.34 to 7.97 percent respectively. The highest fat content was observed for sample T3 i.e. 7.97 percent and highest protein T3 i.e. 22.93 percent. The highest carbohydrate content was reported in case of sample T3 i.e. 56.32 percent which contained 30 percent garden cress seed powder. Mean value for ash content were 7.37, 6.28, 6.71 and 7.16 percent for sample T0, T1, T2 and T3 respectively.

Findings obtained for mineral composition of papad had been noticed to calcium content was notice to be 155 mg/100g, iron 4.44 mg/100g and zinc 0.48
mg/100g. The higher amount of ash content indicates that the garden cress seed are good source of minerals.

Attempt has been made to study the effect of storage period and different packaging material on moisture content, texture and flavour showed that there was no remarkable change in the moisture content was observed during course of storage period in case of all the packaging material and samples throughout the storage period. Although there was no remarkable changes in texture and flavour also upto 90 days and it is noticed that papad lose their crispiness after a period of 90 days and decreases as storage period advances. Overall it can be suggested that papad packaged in aluminium foil pouches and HDPE for a period of 120 days can be packaged without any deteriorative changes. Microbial quality of papad indicated that yeast and mould observed to be $1.7 \times 10^2 \text{ cfu/g}$ whereas the total plate count $1.2 \times 10^2 \text{ cfu/g}$.

Overall, the efforts taken to assess the total energy value sample the highest energy value was reported in case of sample T3 i.e. 421.23 Kcal/100g compared to control and other samples. As indicated that sample T3 contained 30 percent garden cress seed had higher energy value as garden cress seed is potential source of carbohydrate, proteins, and lipids indicates good source of energy.

Sincere efforts taken to study the total cost for production of 1 kg papad including processing and packaging cost at 15 percent of raw material cost was calculated to be 145.82 rupees whereas cost for production of 10 kg papad were 1458.2 rupees. The cost calculated for bulk production can give idea about commercial exploitation of product.

**Conclusion**

In light of the fact and figures of the present investigation it can be finally concluded that garden cress seed contains essential nutrients like carbohydrates, fats, protein, dietary fiber and essential minerals make it potential ingredients in
formulation of papad. Therefore, good quality papad can be prepared with addition of 10 percent gardencress powder having high nutritive value and sensory acceptability. It can be conclude that prepared papad can be very well stored in aluminium foil pouches and HDPE for 120 days without any undesirable changes. In short, the papad supplement with 10 percent garden cress seed is technoeconomically feasible and can be commercially exploited.
LITERATURE CITED:


Ranganna S. (1986). Handbook of analysis and quality control for fruit and vegetable products II nd Ed.


Sensory Evaluation Report

Name of Product:__________________________________
Name of Evaluator:_____________________________
Designation:____________________________________

Sensory Values for Product:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sample</th>
<th>Colour</th>
<th>Appearance</th>
<th>Flavour</th>
<th>After taste</th>
<th>Texture</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Toasted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fried</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>Toasted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fried</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>Toasted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fried</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>Toasted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fried</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks

The 9-Point Hedonic Scale Rating:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike Extremely</td>
<td>1</td>
</tr>
<tr>
<td>Dislike Very Much</td>
<td>2</td>
</tr>
<tr>
<td>Dislike Moderately</td>
<td>3</td>
</tr>
<tr>
<td>Dislike Slightly</td>
<td>4</td>
</tr>
<tr>
<td>Neither Like Nor Dislike</td>
<td>5</td>
</tr>
<tr>
<td>Like Slightly</td>
<td>6</td>
</tr>
<tr>
<td>Like Moderately</td>
<td>7</td>
</tr>
<tr>
<td>Like Very Much</td>
<td>8</td>
</tr>
<tr>
<td>Like Extremely</td>
<td>9</td>
</tr>
</tbody>
</table>

Sing of Evaluator
Plate 1. Raw Gardencress seed
Plate 2. Roasted Gardencress seed
Plate 3. Roasted Gardencress seed powder
Plate 4. Black gram flour
Plate. 6. Colorometer (ColorFlex EZ)
Plate. 5. Texturometer (Stable Micro System TAXT2 plus)
Fig 7. Textural properties of raw papad
Fig. 8. Textural properties of fried papad
Fig. 9. Textural properties of toasted papad
Plate. 22. Total Plate Count

Plate. 23. Yeast and Mold
Plate 13. T2 Raw

Plate 14. T2 Toasted

Plate 15. T2 Fried
Plate. 19. Sample (T1) Storage in HDPE

Plate. 20. Sample (T1) Storage in Steel Box

Plate. 21. Sample (T1) Storage in Aluminium Foil Pouches