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Effect of processing on the functional properties of Garden cress seeds and development of garden cress seed flour incorporated Instant soup mix and RTC Chapati

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Abstract
Lepidium Sativum L. commonly known as Garden cress, is a member of the Brassicaceae family. It is an important source of iron, folic acid, calcium, vitamins C, E and A. Alkaloids, flavonoids, glucosinolates, sterols, and tannins are important phytochemical constituents, which impart pharmacological characteristics to garden cress seed. In this study, the Cress seeds were subjected to different processing methods (roasting and germination) and their impact on functional properties were analysed. The evaluation of the organoleptic attributes of developed food products (Instant Soup Mix & RTC Chapati) were made with incorporation of untreated, dry roasted and germinated Garden cress seed powders at 5%,10% and 15% levels. The sensory scores revealed that the 5% incorporation of Garden Cress seed powder was more acceptable in all the products irrespective of the pre-treatments. The pre-treatments not only improved the functional properties, but also had well acceptable sensory attributes.

Keywords: garden cress, roasting, germination, functional properties

1. Introduction
Lepidium Sativum L. commonly known as Garden cress (GC), is a member of the Brassicaceae family. It is an annual, herbaceous edible plant, native to Egypt and South west Asia and was referred to over many centuries ago in Western Europe. It is cultivated in India, as culinary vegetable. The seeds, leaves and roots of garden cress have economic value but its crop is mainly cultivated for its seeds. Garden cress has been considered as an important nutritional and medicinal plant in India since the Vedic era (between 500-1700 B.C.). In Ayurveda, the indigenous medicinal system, it is described as hot, bitter, galactagogue and claimed to destroy vata (air) and kapha (phlegm). Seeds are also rich source of omega 3-fatty acid**s** which helps to lower cholesterol in hyper cholesterolemic patients (Agarwal and Sharma (2013) [2].
Garden cress is commonly known as "Chandrashoor" in various Ayurvedic text of medieval India. The most reputed formulations which are commercially available are "*Chaturbhuja*" which claims to possess a number of therapeutic properties including anti-inflammatory activities (Shail *et al*, 2016) [14]. Traditionally, garden cress seeds have been used for food and allied purposes, without any concern arising about adverse toxicity or health concerns. The *Lepidium Sativum* was used as antidiabetic (Eddouks *et al*, 2008) [6]**,** anti-asthmatic, diuretic (Chopra *et al*), hypotensive (Maghrani *et al*., 2005) [13], anticarcinogenic (Kassie *et al*., 2003) [10], and antibacterial (Aburjai *et al*., 2001) [1] agent.
Indian cooking and lifestyle have undergone tremendous changes in the last 15 years. In today's situation convenience food products have become an essential component in the daily lives of people. The consumption of these instant food products is seeing a very sharp rise because of changes in consumers' taste, lifestyle, their time constraint, easy availability, etc. Drastically changing food habits and a greater demand for convenience food products have led to the growth of processed and packed food manufacturing industries
The current study was undertaken to analyse the impact of roasting and germination on the functional properties of garden cress seed flour and to optimize the use of garden cress seeds in convenience foods-Instant Soup mix and RTC Chapathi.

2. Methodology
2.1 Procurement of ingredients
Garden cress seeds used in the present study were procured from local super market. After cleaning, the seeds were subjected to different processing methods such as roasting and germination and were used for further research.

2.2 Processing of Garden Cress Seeds
2.2.1 Untreated garden cress seed powder
Garden cress seeds were sun dried and hand sorted to remove impurities and foreign particles. Then, they were ground in a mixer and stored in an airtight container

2.2.2 Roasted garden cress seed powder
Garden cress seed were roasted in a griddle and ground in a mixer. Then, this powder is stored in an air sealed container.

2.2.3 Germinated garden cress seed powder
Garden cress seeds were sorted and cleaned to remove impurities. The seeds were spread on damp muslin cloth and were kept at room temperature (32-35 ºc) for 48 hours till seeds get germinated. These fresh germinated seeds were then sun dried and ground in a mixer. Then, this powder is stored in an air sealed container.

2.3 Experimental analysis

The following tests were carried out for the plain, roasted and germinated garden cress flours:

Functional properties: Bulk Density, Water Absorption, Oil Absorption, Swelling Power, Foam Capacity, Emulsion Stability (AOAC 2006) [4]

2.4 Formulation of Garden Cress Incorporated Instant Soup Mix and Garden Cress incorporated Ready- to – Cook Chapati

Table 1: Composition of Garden Cress Incorporated Instant Soup Mix

Ingredients	Quantity
Tomato powder	20g
Onion powder	10g
Garlic powder	1.5g
Ginger powder	1.5g
Corn flour	5g
Salt	5g
Pepper powder	2g

Processed Garden Cress seed powder (Untreated, Roasted and Germinated) are incorporated at 5%, 10% and 15% levels.

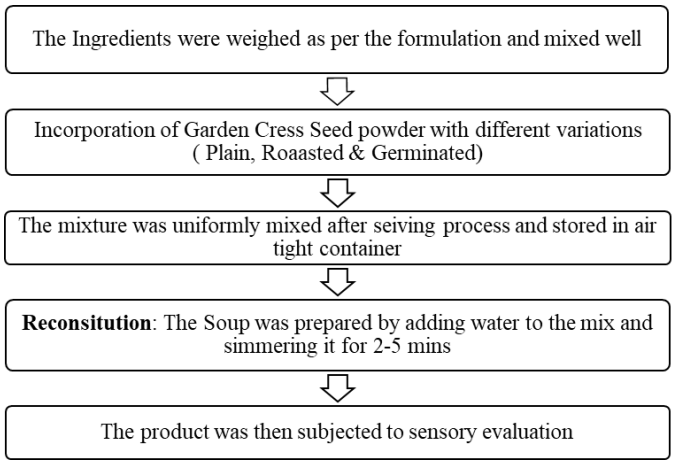


Fig 1: Preparation Process of Garden Cress Incorporated Instant Soup Mix

Table 2: Composition of Garden Cress incorporated Ready- to – Cook Chapati

Ingredients	Quantity
Wheat Flour	450g
Salt	1 tsp.
Water	250ml

Processed Garden Cress seed powder (Untreated, Roasted and Germinated) are incorporated at 5%, 10% and 15% levels.

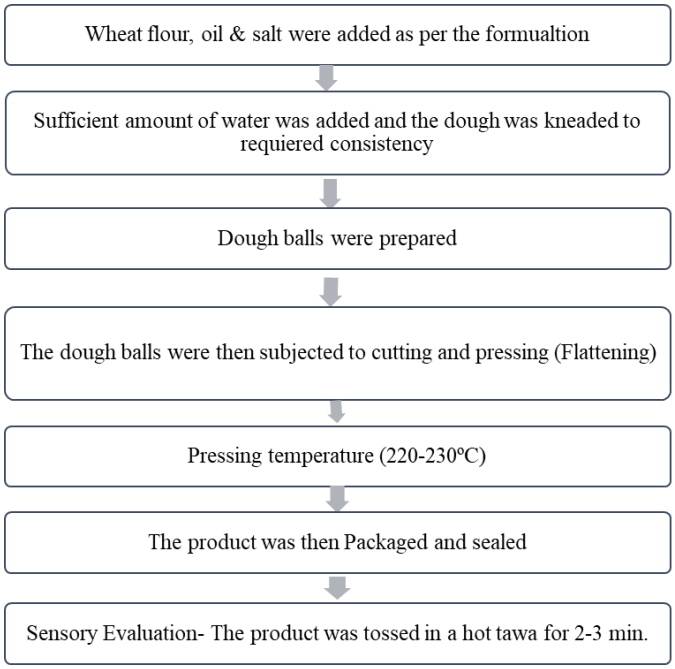


Fig 2: Preparation Process of Garden Cress incorporated Ready –to-Cook Chapati

2.5 Sensory analysis

Sensory evaluation was carried out for all the variations on a 9 – point hedonic scale rating by 16 semi- trained panellists. Each panellist was given a sensory evaluation sheet and the cookies were rated for parameters such as colour, flavour, texture, taste, crunchiness, breakability, mouth feel, after taste and overall acceptability

2.6 Statistical analysis

All the experimental analysis was carried out in triplicates. Data were reported as mean and standard deviation. Paired t test was carried out to compare the significant difference between the plain flour and the germinated flour and also between plain flour and dry roasted. One way ANOVA was carried out to validate if there was any significant difference in the nutritive value and functional properties among the three flours and also to analyse any significant difference in the sensory attributes of the cookie variations. Data analysis was done using SPSS version 20.0.

3. Results & discussion

3.1 Functional properties of processed garden cress seed powder

Bulk density

Bulk density is generally affected by the particle size and density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in food industry (Karuna *et al*., 1996) [9]

The bulking property of a powder alters according to the preparation methods, different treatments administered and storage. The density of the processed products or the uniqueness of its container determines the amount and strength of packaging material (Wilhelm *et al.,* 2004) [16].

The Bulk density of untreated, roasted and germinated were found to be 1±0.5g/ml, 0.63±0.01g/ml and 0.83±0.09g/ml respectively

There was a significant ($p<0.05$) 37% and 17% decrease in bulk density on dry roasting and germinated samples.

This result is in agreement with Akubor and Obiegbuna (1999) [3] who observed lesser bulk density value for germinated millet flour. Similarly, Ghavidel and Prakash (2006) [8] reported reduced bulk density for germinated green gram, cowpea, lentil and Bengal gram.

Water Absorption Capacity

The water and oil binding capacity of food protein depend upon the intrinsic factors like amino acid composition, protein conformation and surface polarity or hydrophobicity. WAC of flour is closely linked to both amount of amino acids in different flours and availability of proteins functional groups in flour (Kouakou *et al*., 2013) [12].

The water absorption levels of untreated, roasted and germinated garden cress seeds were 9.56±0.40ml/g, 8.93±0.30ml/g and 9.8±0.31ml/g respectively. There was a significant ($p<0.05$) 6.58% decrease in water absorption on dry roasting of garden cress seed powder, whereas a 2.5% increase in water absorption was found on germination. It can be assumed that the polar amino acid residues of proteins with substantial attraction for water molecules could have increased the water absorption capacity on germination.

Oil Absorption capacity

Oil absorption capacity (OAC) is an essential property to develop novel food products and store them for a long period. Flavor and mouth feel of food depends on the fat molecules present in the flour to some extent (Kinsella, 1976) [11].

The oil absorption capacity of untreated, roasted and germinated garden cress seeds were 7±0.72ml/g, 7.4±1.07ml/g & 7.9±0.64ml/g respectively. There was a 5.71% and a 12.85% increase in oil absorption capacity of garden cress seed powders on dry roasting and germination respectively. The result is in agreement with the reports outlined by Elkhalifa *et al*., (2010) [7] for germinated sorghum flour.

In a study by Vandarkuzhali and Sangeetha, (2016) [15], the OAC of germinated horse gram flour for 48h and 72h exhibited significant increase ($p<0.05$) from 1.15ml/gm to 1.83 ml/gm than the control sample and the sample obtained after 24 h germination. Decreased fat content upon germination could also be attributed to the increase in consumption of oil in its structure.

Swelling power

Swelling capacity is the volume of expansion of molecule due to the consumption of water up to a level where the colloidal suspension is complete (Ayernor *et al*, 2002) [5]. In addition, bonding forces and starch species present in the flour determine the degree of swelling and solubility of the flour.

The swelling capacity of untreated, roasted and germinated garden cress seed powder were recorded as, 11.2±0.68%, 12.1±0.69% and 8.3±0.52% respectively. There was a significant ($p<0.05$) 8% increase in swelling capacity on dry roasted sample. There was a 31% decrease in the swelling capacity on germination which was also statistically significant ($p<0.05$).

Table 3: Functional properties of processed garden cress seed powder

Sample/ Parameters	Untreated Garden Cress powder	Roasted Garden Cress	Germinated Garden Cress
Bulk Density (g/cm^3)	1±0.5	0.63±0.01 ^{NS} (-37)^1	0.83±0.09 ^{NS} (-17)^1(+31.74)^2
Oil absorption (g/ml)	7±0.72	7.4±1.07 ^{NS} (+5.71)^1	7.9±0.64 ^{NS} (+12.85)^1(+6.75)^2
Swelling Capacity (%)	11.2±0.68	12.1±0.69* (+8.03)^1	8.3±0.52**(-25.89)^1(-31.50)^2
Water absorption (g/ml)	9.56±0.40	8.93±0.30* (-6.58)^1	9.8±0.34** (+2.51)^1(+9.37)^2

[1] depicts the percent increase or decrease between Untreated and Roasted Garden cress powder and between Untreated and Germinated garden cress powder.

[2] depicts the percent increase or decrease between Roasted and Germinated Garden Cress powder

* Significant difference on dry roasting

** Significant difference on germination

^{NS} Depicts no significant difference on pre- treatment

3.2 Sensory Parameters

Sensory evaluation involves the measurement and interpretation of the sensory characteristics of food products through the use of human subjects acting as judges. Sensory evaluation brings valuable information on quality characteristics. The comparison of the sensory attributes were made among the untreated and processed (roasted & germinated) garden cress samples with different levels of incorporations (5%, 10% and 15%), for products (Instant Soup Mix and Ready -to-cook Chapati).

One way ANOVA analysis for the sensory attributes of the products (Instant soup mix & RTC Chapati) prepared with untreated, roasted and germinated GC powder with 5%, 10% and 15% incorporation revealed that there was a significant difference ($p<0.05$) among the experimental samples

Table 4: Product code for Garden Cress incorporated Instant Soup Mix

CS	Control Soup (Without Garden cress incorporation)
UTS1	Soup incorporated with 5% untreated GCS powder
UTS2	Soup incorporated with 10% untreated GCS powder
UTS3	Soup incorporated with 15% untreated GCS powder
RGS1	Soup incorporated with 5% roasted GCS powder
RGS2	Soup incorporated with 10% roasted GCS powder
RGS3	Soup incorporated with 15% roasted GCS powder
GGS1	Soup incorporated with 5% germinated GCS powder
GGS2	Soup incorporated with 10% germinated GCS powder
GGS3	Soup incorporated with 15% germinated GCS powder

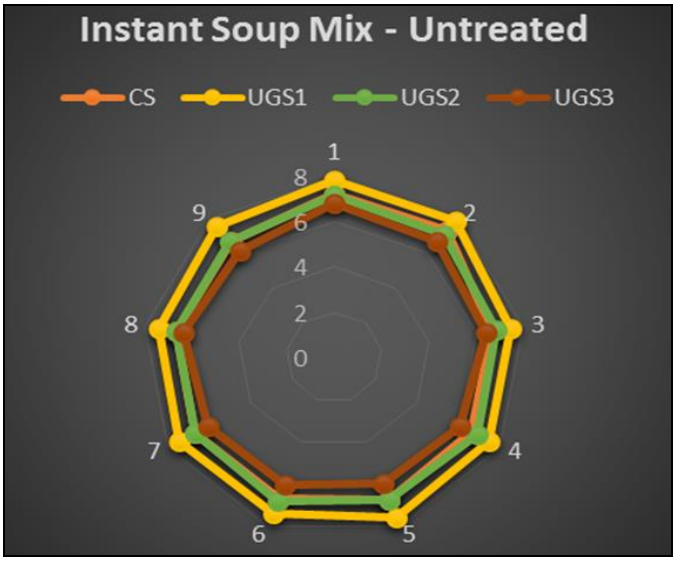
Table 5: Product code for Garden cress incorporated RTC Chapati

CC	Control Chapathi (Without Garden cress incorporation)
UTC1	Chapati Incorporated with 5% untreated GCS powder
UTC2	Chapati Incorporated with 10% untreated GCS powder
UTC3	Chapati incorporated with 15% untreated GCS powder
RGC1	Chapati Incorporated with 5% roasted GCS powder
RGC2	Chapati incorporated with 10% roasted GCS powder
RGC3	Chapati Incorporated with 15% roasted GCS powder
GGC1	Chapati incorporated with 5% germinated GCS powder
GGC2	Chapati Incorporated with 10% germinated GCS powder
GGC3	Chapati Incorporated with 15% germinated GCS powder

Sensory Attributes of Garden Cress incorporated Instant Soup Mix:

Among the Instant Soup mix prepared from untreated, roasted and germinated garden cress, the overall acceptability ranked highest for germinated garden cress (5%) incorporated soup mix (GGS1) with a mean score of 8.5±0.57, followed by roasted (RGS1) garden cress soup mix with a score of 7.66±0.48 and untreated (UGS1) garden cress soup mix with a score of 7.6±050.

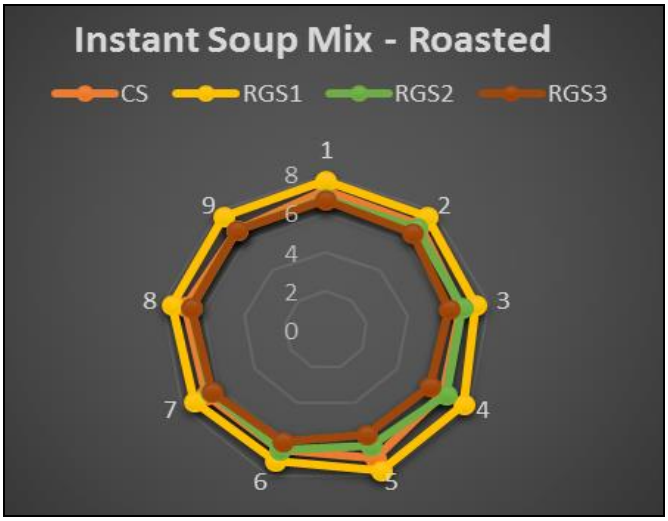
Instant Soup Mix with 5% incorporation had the wide acceptance in comparison with the control and other variations in consideration with the parameters like appearance, colour, taste, flavor, mouth feel, consistency, after taste and overall acceptability



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Consistency, 8= after taste, 9= Overall acceptability

Fig 3: Sensory parameters of Untreated Garden Cress Soup Mix

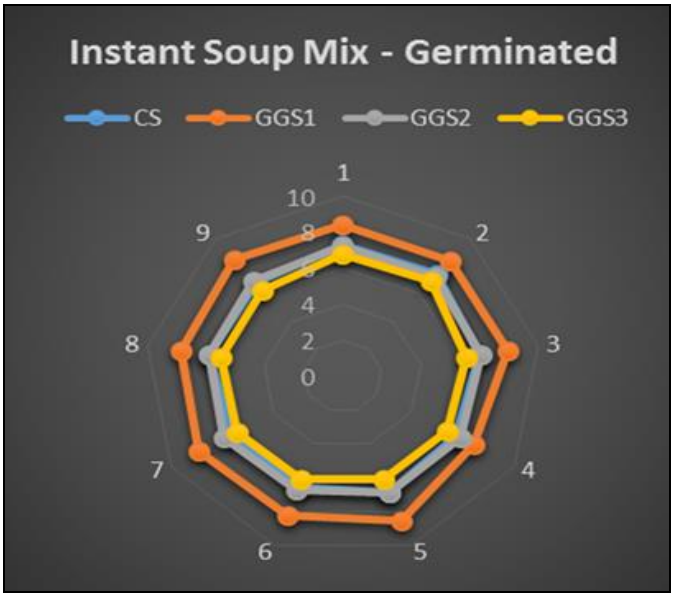
From Fig 3, we can infer that UGS1 (5% untreated garden cress incorporated soup mix) was highly accepted with a mean score of 7.6±0.50



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Consistency, 8= After taste, 9= Overall acceptability

Fig 4: Sensory parameters of Roasted Garden Cress Soup Mix

From figure 4, we can infer that RGS1 (5% roasted garden cress incorporated soup mix) was highly accepted with a mean score of 7.66±0.48



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Consistency, 8= after taste, 9= Overall acceptability

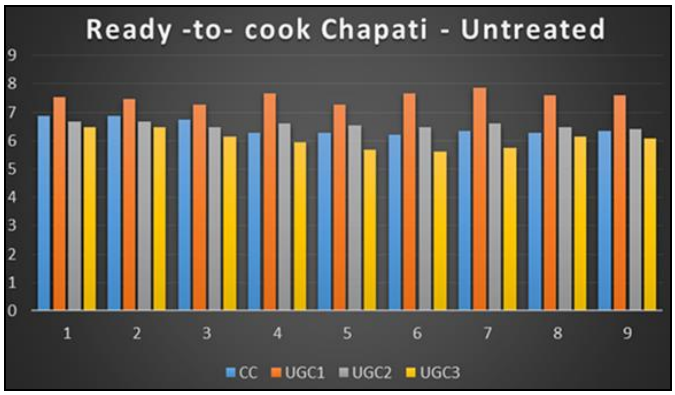
Fig 5: Sensory parameters of Germinated Garden Cress Soup Mix

From figure 5, we can infer that GGS1 (5% germinated garden cress incorporated soup mix) was highly accepted with a mean score of 8.5±0.57

Sensory Attributes of Garden Cress incorporated Ready -to- Cook Chapati

Among the RTC Chapati prepared from untreated, roasted and germinated garden cress, the overall acceptability ranked highest for roasted garden cress (5%) incorporated RTC Chapati (RGC1) with a mean score of 7.86±0.63, followed by untreated (UGC1) garden cress RTC Chapati with a score of 7.6±0.50 and germinated (GGC1) garden cress RTC Chapati with a score of 7.4±050.

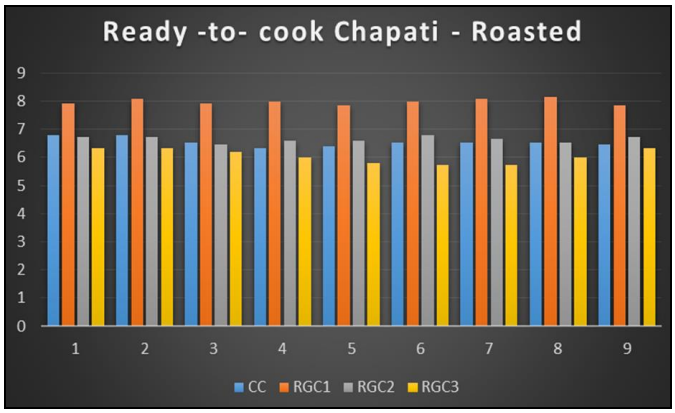
Ready-to – cook chapati with 5% incorporation had the wide acceptance in comparison with the control and other variations in consideration with the parameters like appearance, colour, texture, taste, flavor, mouth feel, tearing strength, after taste and overall acceptability.



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Tearing strength s, 8= after taste, 9= Overall acceptability

Fig 6: Sensory parameters of Untreated Garden Cress Ready -to- Cook Chapati

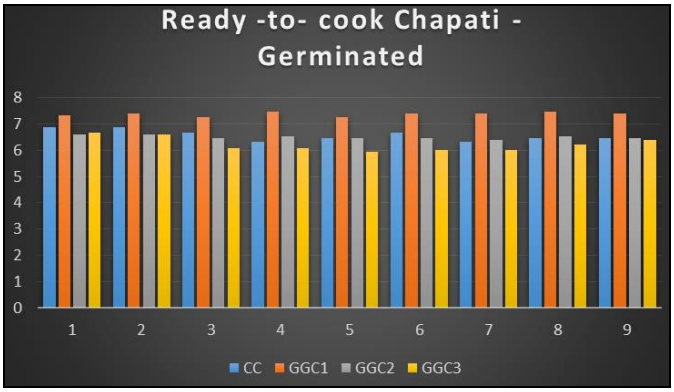
From fig 6, we can infer that UGC1 (5% untreated garden cress incorporated ready -to- cook chapati) was highly accepted with a mean score of 7.6±0.50



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Tearing strength s, 8= After taste, 9= Overall acceptability

Fig 7: Sensory parameters of Roasted Garden Cress Ready -to- Cook Chapathi

From fig 7, we can infer that RGC1 (5% roasted garden cress incorporated ready -to- cook chapati) was highly accepted with a mean score of 7.86±0.63



*1= Appearance, 2= Color, 3= Texture, 4= Taste, 5=Flavour, 6= Mouth feel, 7=Tearing strength s, 8= After taste, 9= Overall acceptability

Fig 8: Sensory parameters of Germinated Garden Cress Ready -to- Cook Chapathi

From fig 8, we can infer that GGC1(5% germinated garden cress incorporated ready -to- cook chapati) was highly accepted with a mean score of 7.4±0.50

4. Conclusion

The consumers demand has increased for the food products with taste, safety, convenience and nutrition. Thus nutrition has emerged an added dimension in the chain of food product development. A number of non-conventional food stuffs have been explored, analysed, processed and used up in the development of food products, Garden cress (*Lepidium Sativum* L.) is one such food stuff that abounds not only in nutrients but also in health enhancing phytochemicals.

Hence the study, "Effect of Processing on Selected functional properties of Garden cress seeds and development of Garden cress seed based instant soup mix and RTC Chapati" was undertaken. In this study, the Garden cress seeds were subjected to different processing methods- roasting and germination and its impact on the functional properties were analysed. Development and optimization of convenience foods (Instant Soup mix & Ready –to – cook Chapati) with incorporation of Garden cress were also carried out. The study concludes that, the pre-treatments (Dry roasting & Germination) not only improves the functional properties, but also has well acceptable sensory attributes. 5% incorporation of Garden cress seed powder was widely acceptable in both the products irrespective of pre-treatments.

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