International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 6; November 2018; Page No. 171-175

Comparative study of microgreens with mature greens incorporated ready-to-eat chutney powders

Nivedha V[1], Lakshmy Priya S[2]
[1] M.Sc. Food Technology and Management, School of Food Science, MOP Vaishnav College for Women Autonomous, Chennai, Tamil Nadu, India
[2] Assistant Professor, School of Food Science, MOP Vaishnav College for Women Autonomous, Chennai, Tamil Nadu, India

Abstract
Microgreens are a new class of edible vegetables harvested when first leaves have fully expanded and before true leaves have emerged. They are gaining popularity as a new culinary ingredient. They are used to enhance salads or as edible garnishes to embellish a wide variety of other dishes. The consumption of microgreens has nowadays increased due to higher concentrations of bioactive components such as vitamins, minerals and antioxidants than mature greens, which are important for human health. However, they typically have a short shelf life due to rapid product deterioration. The main objective of this study is to bring to light the high nutritional value of microgreens that is being left unnoticed by people. The objective is achieved by developing ready-to-eat chutney powders using microgreens and mature greens and by comparing their nutritional content. Among the wide variety of available microgreens- amaranth, beet, lettuce, microgreen mix, radish, mustard, sunflower and peas were chosen to compare their benefits with mature greens amaranth, beet, lettuce and radish. In addition to this comparative study, a pilot study was also conducted among people of different age categories to document people's awareness, knowledge and attitude towards microgreens.

Keywords: microgreens, mature greens, ready-to-eat chutney powders, awareness

1. Introduction
Microgreens became popular in the middle of 1990s in California and the first use of the word "Microgreens" was documented in 1998. Commercial cultivation starts to take place in the second half of the 1990's in the Southern part of California [1].
Microgreens are usually 1-3 inches in height, harvested at 7-14 days after germination, depending on the species, and sold with the stem and attached cotyledons (seed leaves). Although small in size, microgreens can provide a large array of intense flavors, vivid colors and tender textures [2].
Commonly found microgreens are amaranth, beet, lettuce, radish, mustard, sunflower and peas. Regarding the cultivating conditions, microgreens are a versatile product. They may be grown: In greenhouse or indoor, with natural or artificial light sources and in soil or in soilless systems [3].
Green leafy vegetables are used as an important food source in all parts of the world and they are rich sources of bioactive compounds, minerals, and dietary fibres. However, leafy vegetables deteriorate very quickly after harvest due to their perishable nature and become unfit for consumption and furthermore, some of them are not available throughout the year. One way to preserve such plant products is to dry them in order to preserve their desirable qualities, reduce storage volume and to extend shelf-life. In addition, it is also important to retain the biological activity of important phytoconstituents, including antioxidants and nutrients as well as avoid undesirable chemical or physical changes like browning and loss of colour [4].
Limited studies on nutrient analysis of microgreens incorporated food products have shown that research on microgreens needs to be explored. Thus the study on "Comparative study of Microgreens with Mature Greens incorporated ready-to-eat chutney powders" has been carried out with the objective of developing nutrient dense microgreen recipes.

2. Materials and Methods
A questionnaire was formulated with the objective towards finding the consumer's awareness, knowledge and attitude towards microgreens. The questionnaire was distributed to 50 respondents. The first section of the questionnaire consists of demographic information such as Name, Age, Educational qualification and Occupation. The respondents were classified into four different categories based on age as follows, 15-25 yrs, 25-35 yrs, 35-45 yrs, and 45-55 yrs. The second section of the questionnaire deliberates about the consumer awareness towards microgreens.
The raw materials such as microgreens, mature greens, curry leaves, Bengal gram dal, Urad dal, red chillies, tamarind, asafoetida and salt were purchased from a local market in Chennai city.
The RTE chutney powders meant for the study were prepared through the incorporation of microgreens and mature greens. The control was prepared using curry leaves (code: C).
The microgreens and mature greens chutney powder samples were coded as follows:

Table 1: Codes assigned to chutney powders

Code	Samples
Microgreens powder	**Mp**
Mp 1	Amaranth leaves
Mp 2	Beet leaves
Mp 3	Lettuce leaves
Mp 4	Mix of all microgreen leaves
Mp 5	Mustard leaves
Mp 6	Peas leaves
Mp 7	Radish leaves
Mp 8	Sunflower leaves
Mature greens powder	Glvp
Glvp 1	Amaranth leaves
Glvp 2	Beet leaves
Glvp 3	Lettuce leaves
Glvp 4	Radish leaves

The composition and method of preparation of the ready to eat chutney powder has been given below

Table 2: Composition of experimental chutney powders

Ingredients	Quantity
Microgreens/ Mature greens/ Curry leaves	25 grams
Bengal gram dal	1/4 cup
Urad dal	1/4 cup
Red Chillies	5 nos
Tamarind	5 grams
Asafoaetida	A pinch
Salt	To taste

Flow chart for the preparation of control, microgreens and mature greens chutney powder

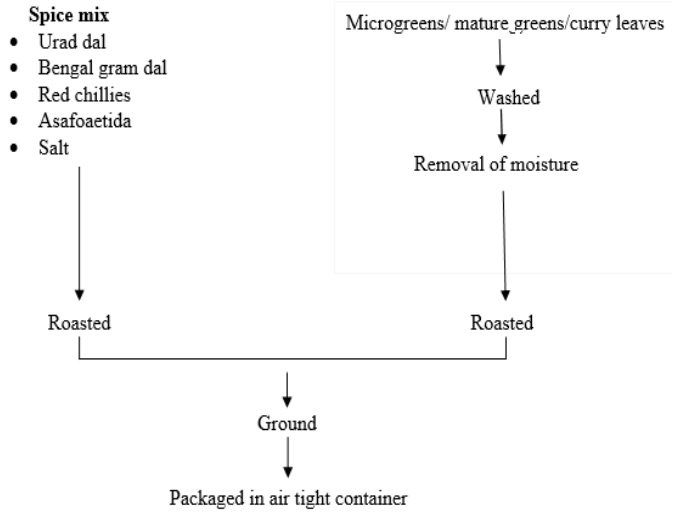

Fig 1

2.1 Experimental analysis

The comparative nutrient analyses such as proximate analysis (moisture, ash, protein), micronutrient analysis (iron, calcium, phosphorous) and polyphenols test were conducted for four microgreen (Amaranth, Beet, Lettuce and Radish) and four mature green (Amaranth, Beet, Lettuce and Radish) incorporated chutney powders. They were grouped into four categories,

Table 3: Codes assigned to chutney powder groups

Group	Name	Codes assigned
1	Amaranth microgreen and Amaranth mature green	Mp 1 and Glvp 1
2	Beet microgreen and Beet mature green	Mp 2 and Glvp 2
3	Lettuce microgreen and Lettuce mature green	Mp 3 and Glvp 3
4	Radish microgreen and Radish mature green	Mp 4 and Glvp 4

The rest four microgreen (Microgreens mix, Mustard, Peas and Sunflower) incorporated chutney powders were analysed for its nutrient content and organoleptic properties.

2.2 Sensory Evaluation

Chutney powders were evaluated by a panel of 5 semi-trained panelists for the sensory attributes of appearance, colour, flavour, taste, texture, aftertaste and overall acceptability using a 9 point hedonic scale. At each testing session, each panelist judged 13 chutney powder samples. The order of presentation of the samples to the panel was randomized. Potable drinking water was provided for the panelists to rinse between evaluations.

3. Results and Discussion

3.1 Analysis of awareness towards microgreens

A questionnaire was circulated among 50 respondents of age group 15-55 years to elicit information about their awareness, knowledge and attitude towards microgreens.

The respondents were divided into 4 categories: Age (yrs)

- 15-25 (40% - 20 respondents)
- 25-35 (20% - 10 respondents)
- 35-45 (20% - 10 respondents)
- 45-55 (20% - 10 respondents

The majority of the respondents (54%) were unaware about microgreens, 36% respondents were somewhat aware about them and 10% were very much fond of microgreens.

Most of the respondents (90%) have never consumed microgreens leaving it to be an unsought nutritional treasure.

Majority of the respondents (46%) prioritize Nutritional benefits to the other factors as greens are generally high in nutrients. Following nutritional benefits, Taste is the second in opinion (22%). Some people (20%) consider microgreens as a decorative ingredient for garnishing. 12% of the respondents prefer taste over decoration to be the second reason for using microgreens.

Most of the respondents (50%) consider microgreens to be used as a cooking ingredient. 22% consider it be used in soups and salads. 18% consider it be used as garnish for soups and salads. The remaining (10%) consider all the above factors.

The major reasons for not adopting microgreens were due to the unawareness of microgreens (36%), whereas (20%) of the respondents dint adopt microgreens because of the unavail-ability. Very few respondents (14%) felt that price is a factor for not adopting microgreens and the rest 30 % of respondents strongly felt both unavailability and unawareness were major factors that prevented them from adopting microgreens.

Owing to lack of awareness among people, majority of them

(62%) consider mature greens more nutritional than microgreens (38%).

3.2 Proximate composition of control and experimental samples

The comparative nutrient analysis were conducted for four microgreen (Amaranth, Beet, Lettuce and Radish) and four mature green (Amaranth, Beet, Lettuce and Radish) incorporated chutney powders. They were grouped into four categories (Refer Table 3.4).

The rest four microgreens (Microgreen mix, Mustard, Peas and Sunflower) incorporated chutney powders were analysed for its nutrient content and organoleptic properties.

3.2.1 Moisture

The moisture content of the control chutney powder was found to be 4.58g (±0.36) whereas the experimental microgreens chutney powder ranges between 6.17g (±0.06) (MP 2)) and 14.53g (±0.40) (MP 5).When comparing the moisture content of the mature green and microgreen incorporated chutney powders, lettuce mature green chutney powder showed highest value 14.82g (±0.24) while beet microgreen chutney powder showed the lowest value 6.17g (±0.06). Overall control chutney powder showed the lowest value 4.58g (±0.36). The analysis of variance showed that there was no significant difference (P>0.05) between the mature green and microgreen incorporated chutney powders.

The result of the current study was similar to the result obtained in the study of Physico-Chemical composition of chutney powder where the moisture content of curry leaves chutney powder was found to be 5±0.11g which is similar to that of control chutney powder [5].

3.2.2 Protein

The protein content of the control chutney powder was found to be 19.37g (±0.07) whereas the experimental microgreens chutney powder ranges between 20.59g (±0.28) (MP 5) and 44.23g (±0.11) (MP 2). When comparing the protein content of the mature green and microgreen incorporated chutney powders, beet microgreen chutney powder showed highest value 44.23g (±0.11) while Amaranth mature green chutney powder showed the lowest value 20.62g (±0.27). Overall the control chutney powder had the lowest protein content 19.37g (±0.07). The analysis of variance showed that there was a significant difference (P<0.05) between the mature greens and microgreens chutney powders. The protein content of amaranth, beet, lettuce and radish microgreen chutney powders was higher than the mature green incorporated chutney powders.

3.2.3 Ash

The ash content of the control chutney powder was found to be 4.69g (±0.41) whereas the experimental microgreens chutney powder ranges between 4.65g (±0.06) (MP 7) and 6.63g (±0.28) (MP 5).When comparing the ash content of the mature green and microgreen incorporated chutney powders, Radish mature green chutney powder showed the highest value 6.55g (±0.09) while the lowest value was found in radish microgreen chutney powder 4.65g (±0.06). Overall mustard microgreen chutney powder showed the highest value 6.63g (±0.28). The analysis of variance showed that there was no significant difference (P>0.05) between the mature greens and microgreens chutney powders.

3.2.4 Iron

The iron content of the control chutney powder was found to be 9.50mg (±0.14) whereas the experimental microgreens chutney powder ranges between 5.35mg (±0.02) (MP 3) and 16.48mg (±0.41) (MP 8). When comparing the iron content of the mature green and microgreen incorporated chutney powders, Radish microgreen chutney powder showed highest value 15.13mg (±0.02) while the lowest value was found in lettuce microgreen chutney powder 5.35mg (±0.02). Overall sunflower microgreen chutney powder showed the highest value 16.48mg (±0.41). The analysis of variance showed that there was no significant difference (P>0.05) between the mature greens and microgreens chutney powders.

3.2.5 Calcium

The calcium content of the control chutney powder was found to be 25.6±0.04mg and the calcium content for the experimental microgreen incorporated chutney powders ranges from 15.66mg (±0.02) (MP 4) and 29.23mg (±0.03) (GLVP 4). When comparing the calcium content of the mature green and microgreen incorporated chutney powders, Radish mature green chutney powder showed highest value 29.23mg (±0.03) while the lowest value was found in amaranth mature green chutney powder 18.13mg (±0.03). The analysis of variance showed that there was no significant difference (P>0.05) between the mature greens and microgreens chutney powders. The calcium content of beet, lettuce and radish mature green chutney powders were found to be higher when compared to beet, lettuce and radish microgreen chutney powders whereas amaranth microgreen chutney powder had higher calcium content when compared to amaranth mature green chutney powder.

3.2.6 Phosphorous

The phosphorous content of the control chutney powder was found to be 258.58mg (±0.05) and the phosphorous content for the experimental microgreen incorporated chutney powders ranges from 156.27mg (±0.02) (GLVP 2) and 261.47mg (±0.06) (MP 8). When comparing the phosphorous content of the mature green and microgreen incorporated chutney powders, Radish microgreen chutney powder showed highest value 245.57mg (±0.14) while the lowest value was found in beet mature green chutney powder 156.27mg (±0.02). The analysis of variance showed that there was a significant difference (P<0.05) between the mature greens and microgreens chutney powders. The phosphorous content of amaranth, beet, lettuce and radish microgreen chutney powders was higher when compared to amaranth, beet, lettuce and radish mature green powder.

3.2.7 Polyphenol

The polyphenol content of the control chutney powder was found to be 5.37mg (±0.04) and the polyphenol content for the experimental microgreen incorporated chutney powders ranges from 4.63mg (±0.07) (GLVP 1) and 48.52mg (±0.14) (MP 2). When comparing the polyphenol content of the

mature green and microgreen incorporated chutney powders, Beet microgreen chutney powder showed highest value 48.52mg (±0.14) while the lowest value was found in amaranth mature green chutney powder 4.63mg (±0.07). The analysis of variance showed that there was a significant difference (P<0.05) between the mature greens and microgreens chutney powders. The polyphenol content of amaranth, beet and radish microgreens were higher when compared to mature greens, whereas lettuce mature green chutney powder had high polyphenol content when compared to lettuce mature green chutney powder.

Table 4: Proximate composition of microgreen and mature green incorporated rte chutney powders

Samples	Moisture	Protein	Ash
Control	04.58±0.36	19.37±0.07	4.7±0.41
MP 1	14.18±0.27	36.76±0.19	5.27±0.19
MP 2	6.17±0.06	44.23±0.11	5.81±0.44
MP 3	7.94±0.47	42.45±0.19	5.50±0.12
MP 4	13.43±0.23	40.98±0.14	5.75±0.44
MP 5	14.53±0.40	20.59±0.28	6.63±0.28
MP 6	13.03±0.60	33.39±0.16	5.85±0.09
MP 7	9.26±0.53	36.4±0.33	4.65±0.06
MP 8	12.66±0.51	34.35±0.21	4.96±0.16
GLVP 1	12.27±0.15	20.62±0.27	5.71±0.12
GLVP 2	7.50±0.23	37.26±0.03	6.13±0.09
GLVP 3	14.82±0.24	22.30±0.10	4.81±0.15
GLVP 4	10.55±0.08	23.95±0.14	6.55±0.09

Table 5: Mineral and polyphenol composition of microgreen and mature green incorporated rte chutney powders

Samples	Iron	Calcium	Phosphorous	Polyphenols
Control	09.50±0.14	25.6± 0.04	258.58±0.05	05.37±0.04
MP 1	13.28±0.04	20.7±0.09	197.42±0.03	06.15±0.08
MP 2	14.61±0.05	25.05±0.04	229.79±0.09	48.52±0.14
MP 3	5.35±0.02	24.89± 0.02	245.39±0.11	9.53±0.05
MP 4	12.56±0.02	15.66± 0.02	213.54±0.04	17.08±0.05
MP 5	14.25±0.03	12.48± 0.07	215.85±0.07	12.41±0.04
MP 6	9.35±0.03	15.86± 0.03	213.27±0.03	33.46±0.04
MP 7	15.13±0.02	27.55± 0.04	245.57±0.14	37.37±0.02
MP 8	16.48±0.41	22.16± 0.02	261.47±0.06	7.13±0.03
GLVP 1	12.93± 0.05	18.13± 0.03	166.85±0.03	4.63±0.07
GLVP 2	13.44± 0.02	26.75± 0.08	156.27±0.02	47.91±0.09
GLVP 3	6.68 ±0.07	27.58± 0.01	209.17±0.04	21.75±0.19
GLVP 4	13.35± 0.03	29.23± 0.03	177.51±0.28	35.16±0.20

3.3 Sensory analysis of ready-to-eat chutney powders

The comparative sensory analyses were conducted for four microgreen (Amaranth, Beet, Lettuce and Radish) and four mature green (Amaranth, Beet, Lettuce and Radish) incorporated chutney powders. They were grouped into four categories (Refer Table 3).

The rest four microgreen (Microgreens mix, Mustard, Peas and Sunflower) incorporated chutney powders were also analysed for its organoleptic properties.

3.3.1 Comparative sensory analysis of microgreen with mature green ready-to-eat chutney powders

Group 1: The comparison between Amaranth microgreen incorporated chutney powder (MP1) and Amaranth mature green incorporated chutney powder (GLVP1), showed that the appearance 7.9 (±0.22), colour 7.8 (±0.44), flavour 8.6 (±0.54), taste 8.6 (±0.54), after taste 7.8 (±0.44) and overall acceptability 8.2 (±0.44) of amaranth microgreen chutney powder were preferred over Amaranth mature green chutney powder as the panelists felt that the mature greens had a slightly sour taste when compared to the amaranth microgreens. There was a significant difference (P<0.05) in the attributes of the chutney powders.

Group 2: The comparison between Beet microgreen chutney powder (MP 2) and Beet mature green chutney powder (GLVP 2) showed that, the flavour 8.1 (±0.89) and taste 7.8 (±0.83) of the beet microgreen was more preferred than beet mature green incorporated chutney powder as the beet microgreen chutney powder had less aftertaste 7.6 (±0.54) when compared to beet mature green chutney powder 7.1 (±0.89). There was a significant difference (p<0.05) in the attributes of the chutney powders.

Group 3: The comparison between Lettuce microgreen chutney powder (MP 3) and Lettuce mature chutney powder (GLVP 3) showed that, the lettuce mature green chutney powder was highly accepted in terms of colour 8.4 (±0.41), flavour 8.1 (±0.74) and taste 8.3 (±0.67) over the lettuce microgreen chutney powder. There was a significant difference (p<0.05) in the attributes of the chutney powders.

Group 4: The comparison between Radish microgreen chutney powder and Radish mature green chutney powder showed that the radish microgreen chutney powder had a more satisfactory flavour 8.3 (±0.83) and taste 8.1 (±0.89) when compared to the flavour 6.6 (±0.54) and taste 6.4 (±0.54) of radish microgreen chutney powder. There was a significant difference (p<0.05) in the attributes of the chutney powders.

Overall the microgreen chutney powders were highly preferred by the respondents when compared to mature green chutney powders.

Table 6: Sensory evaluation of control chutney powder and microgreen chutney powders

Attributes	Control	MP 1	MP 2	MP 3	MP 4	MP 5	MP 6	MP 7	MP 8
Appearance	7.6±0.54	7.9±0.22	7.9±0.22	7.5±0.5	7.7±0.27	7.1±0.22	7.9±0.22	8.2±0.44	8.2±0.44
Colour	8±0.54	7.8±0.44	7.8±0.27	7.6±0.54	7.6±0.82	7.1±0.22	7.7±0.67	8.4±0.54	8.1±0.22
Flavour	8.2±0.54	8.6±0.54	8.1±0.89	7.8±0.75	7.8±0.67	6.2±0.44	7.3±0.97	8.3±0.83	6.8±0.83
Taste	8.2±0.44	8.6±0.54	7.8±0.83	7.9±0.89	7.6±0.89	6.2±0.44	7.3±0.97	8.1±0.89	6.8±0.83
After Taste	8±0.70	7.8±0.44	7.6±0.54	7.7±0.67	7.6±0.82	6.1±0.22	7.3±0.97	7.6±0.54	6.6±0.54
Texture	7.8±0.44	8.1±0.22	7.9±0.22	8±0.35	7.5±0.61	6.9±0.22	7.7±0.67	8.2±0.44	7.1±0.22
Overall Acceptability	8±0.54	8.2±0.44	7.8±0.44	7.9±0.22	7.5±0.61	7±0.35	7.9±0.22	8.4±0.54	7.2±0.44

Table 7: Sensory evaluation of mature green chutney powders

Attributes	GLVP 1	GLVP 2	GLVP 3	GLVP 4
Appearance	7.2±0.44	7.2±0.44	8.2±0.44	8.1±0.22
Colour	6.9±0.22	7.3±0.67	8.4±0.41	8.1±0.22
Flavour	7.1±0.89	7.1±0.74	8.1±0.74	6.6±0.54
Taste	6.7±0.83	7.2±0.56	8.3±0.67	6.4±0.54
After Taste	7.2±0.90	7.1±0.89	7.7±0.44	6.4±0.54
Texture	7.8±0.44	7.8±0.44	8±0.35	7.6±0.89
Overall Acceptability	7.6±0.54	7.6±0.54	8.1±0.22	7.1±0.22

Overall the microgreen chutney powders were found to be preferred more than mature green chutney powders and the radish microgreen chutney powder was found to be highly accepted and the mustard mature green chutney powder was found to be least acceptable among the respondents.

4. Conclusion

The study was conducted to compare the benefits of microgreens and mature greens by preparing Ready-to-eat chutney powders out of them. In addition to the study, a survey was also conducted among people of different age categories to promote and record the awareness of microgreens among people.

Out of the eight microgreens used in the study, comparative nutrient analyses were conducted for four microgreens (Amaranth, Beet, Lettuce and Radish) and four mature green (Amaranth, Beet, Lettuce and Radish) incorporated chutney powders. The rest four microgreen (Mix of all microgreens, Mustard, Peas and Sunflower) incorporated chutney powders were analysed for its nutrient content and organoleptic properties.

The survey portrayed a clear picture where majority of the people remain unaware of microgreens. Among the very few who are fond of, knowledge on the benefits of microgreens was not observed. The main reason for the unpopularity of microgreens was due to lesser awareness and that they are unavailable to access.

The protein content of microgreens was observed to have twice the protein found in mature green. The beet microgreen chutney powder has the highest protein content among all the chutney powder and amaranth mature green chutney powder was found to have the least protein content. The phosphorous content was observed to be high in sunflower microgreen chutney powder and the lowest in beet mature green chutney powder. The polyphenols were found abundant in Beet microgreen chutney powder whereas amaranth mature green chutney powder had the lowest.

The sensory analyses concluded to prove that the attributes of microgreen incorporated chutney powders outran the attributes of mature green incorporated chutney powder in most of the events.

It may be concluded from the present study that microgreens chutney powder is better compared to mature greens chutney powder which implies that microgreens possess greater benefits over mature greens. Though microgreens have a shorter shelf life, incorporating them in ready-to-eat products will enable the benefits of microgreens available for a prolonged duration. The outcome of this present research can be used as valuable information on microgreens and for the development of microgreen incorporated products.

5. References

1. Di Gioia F, De Bellis P, Mininni C, Santamaria P, Serio F. Physicochemical, agronomical and microbiological evaluation of alternative growing media for the production of rapini (*Brassica rapa* L.) microgreens. Journal of the Science of Food And Agricultur. 2016; 97(4):1212-1219. doi: 10.1002/ jsfa. 7852
2. Xiao Z, Lester G, Luo Y, Wang Q. Assessment of Vitamin and Carotenoid Concentrations of Emerging Food Products: Edible Microgreens. Journal of Agricultural and Food Chemistry. 2012; 60(31):7644-7651. doi: 10.1021/jf300459b
3. Ioniță TS, Zamfirache M. Microgreens - a new food product with great expectations. Romanian journal of biology, Plant Biology. 2016; 61:7-16.
4. Saini R, Shetty N, Prakash M, Giridhar P. Effect of dehydration methods on retention of carotenoids, tocopherols, ascorbic acid and antioxidant activity in Moringa oleifera leaves and preparation of a RTE product. Journal of Food Science and Technology. 2014; 51(9):2176-2182. doi: 10.1007/s13197-014-1264-3
5. Balaswamy K, Jyothirmayi T, Rao D. Studies on Preparation of Curry Leaf (*Murraya Koenigii* L.) Chutney Powder. Foodservice Research International. 2004; 14(3):175-187. doi:10.1111/j.1745-4506.2004.tb00188.