**ABSTRACT**

**Background:** Rasam is a traditional South Indian food, prepared using tamarind juice as a base, with a variety of spices. Rasam, with all its ingredients medicinally claimed for various ailments, is a functional food. Systematic consumption of traditional functional food provides an excellent preventive measure to ward off many diseases. **Objective:** To study rasam for cytotoxic, antimitic, and antiproliferation potential beyond its culinary and nutritional effect. **Materials and Methods:** Brine shrimp lethality assay, onion root tip inhibition assay, and 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay in Calu-6, HeLa, MCF-7 cell lines for four stage-wise samples in the preparation of rasam (RS1, RS2, RS3, and RS4) were studied. **Results:** RS4, the end product of rasam showed high lethality with an LC$_{50}$ value of 38.7 µL/mL. It showed maximum antimitotic activity in a dose-dependent manner compared to other samples with an IC$_{50}$ value of 189.86 µL/mL. RS4 also showed an IC$_{50}$ value of 350.22 and 410.15 µL/mL in MCF-7 and Calu-6 cell lines, respectively. **Conclusion:** From this study, we suggest that rasam is a classic example of traditional functional food and it can treat breast and lung cancer on chronic use. **Key words:** Brine shrimp lethality, Calu-6, HeLa, MCF-7, onion root tip inhibition, Saaru

**SUMMARY**

- Rasam, a South Indian traditional functional food, showed high lethality (LC$_{50}$ = 38.7 µL/mL) against brine shrimps.
- Rasam also showed potential antimitotic activity (IC$_{50}$ = 189.86 µL/mL) by inhibiting the onion root tips.
- Rasam showed an IC$_{50}$ value of 350.22 and 410.15 µL/mL against MCF-7 and Calu-6 cell lines respectively.
- Rasam, when consumed on daily dietary basis, can treat breast and lung cancer.

**INTRODUCTION**

The view that food can have an expanded role that goes well beyond providing a source of nutrients truly applies to traditional functional foods. The systematic consumption of traditional functional food provides an excellent preventive measure to ward off many diseases. Epidemiological randomized clinical trials carried out in different countries have demonstrated numerous health effects related to functional food consumption such as reduction of cancer risk, improvement of heart health, stimulation of immune system, decrease of menopause symptoms, improvement of gastrointestinal health, maintenance of urinary tract health, anti-inflammatory effects, reduction of blood pressure, maintenance of vision, antibacterial effect, antiviral effect, reduction of osteoporosis, and anti-obese effect. Traditional functional foods can help prevent chronic disease or optimize health, therefore reducing health-care costs and improving the quality of life. Spices play very important role in digestive function and the Indian tradition has a long history of use of spice in food as medicines to prevent and treat diseases. Another epidemiological study suggested that curcumin, the bioactive compound of turmeric, as one of the most prevalent nutritional and medicinal compounds used by the Indian population, is responsible for the significantly reduced (4.4 times) prevalence of cardiovascular diseases, metabolic diseases, neurodegenerative diseases, and cancer in India compared to the United States of America. It is also estimated that an adult in India consumes 80–200 mg/day of curcumin and 50 g of garlic in 1 week. Hence, there...
is a realistic possibility to reach a therapeutic dose by daily dietary consumption.\textsuperscript{[4,5]} The world realized only in the 20\textsuperscript{th} century that food plays a major role in disease prevention, but centuries before ancient India has realized the importance of food in health and wellness. Rasam is a very popular South Indian traditional spice soup. It is consumed on daily basis in every South Indian home. It is also called as rasam or chaaru or saaru in different South Indian languages. In a traditional South Indian meal, rasam is preceded by a sambar rice course and is followed by curd rice. Rasam is traditionally prepared using tamarind juice as a base, with a variety of spices which are considered to be good for health.\textsuperscript{[6]} The main spices used in rasam preparation are coriander, garlic, curry leaves, tamarind, cumin, black pepper, mustard, turmeric, red chili, and asafetida.\textsuperscript{[7]} Rasam is a functional food because all ingredients used in the preparation of rasam are medicinally claimed for various ailments. Sambar, another South Indian traditional dish, has shown preventive effect against colon cancer.\textsuperscript{[8]} There is a need to understand traditional systems and visualize the future of medicine and health care. The linkage between “the past” and “the future” of medicine is much more important and can give us “new directions” for better understanding health, disease, and possible solutions.\textsuperscript{[9]}

A study on rasam, which is being consumed from time immemorial, is only an approach of “drug rediscovery.” In view of all the above facts, rasam was studied for cytotoxic, antimitotic, and antiproliferation potential beyond its culinary and nutritional effect.

**MATERIALS AND METHODS**

**Materials**

All ingredients of rasam were purchased from Arokya Organic Shop, Vellore, Tamil Nadu. All utensils used for the preparation of rasam were of Stainless Steel 316 grade (SS 316). Brine shrimp eggs were purchased from Ocean Star International Inc., Snowville, UT, USA. Onion bulbs were purchased from Nutrisirée Organics, Bengaluru, Karnataka. MCF-7 (ATCC HTB-22), passage number 11), HeLa (ATCC CCL2, passage number 13), CALU-6 (ATCC HTB-56, passage number 19) cell lines were procured. 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) reagent, Dulbecco's modified Eagle medium (DMEM), fetal bovine serum (FBS) media, trypsin phosphate versene were purchased from Nutrisirée Organics, Bengaluru, Karnataka. MCF-7 (ATCC HTB-22), passage number 11), HeLa (ATCC CCL2, passage number 13), CALU-6 (ATCC HTB-56, passage number 19) cell lines were procured. 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) reagent, Dulbecco's modified Eagle medium (DMEM), fetal bovine serum (FBS) media, trypsin phosphate versene were purchased from Nutrisirée Organics, Bengaluru, Karnataka. MCF-7 (ATCC HTB-22), passage number 11), HeLa (ATCC CCL2, passage number 13), CALU-6 (ATCC HTB-56, passage number 19) cell lines were procured. 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) reagent, Dulbecco's modified Eagle medium (DMEM), fetal bovine serum (FBS) media, trypsin phosphate versene were obtained from Sigma-Aldrich (Bengaluru, India) and HiMedia Ltd., (Mumbai, India). All other chemicals and solvents were obtained from SD Fine Chemicals (Mumbai, India) and were of analytical grade.

**Preparation of rasam**

Rasam was prepared in five stages as mentioned below.

1. Tamarind fruit pulp mixture (T1): 6.88 g of tamarind fruit pulp was immersed in 450 mL of water for 10 min, and then it was hand crushed for 45 times and strained. The strained liquid was rinsed with 5 mL of water, to which 0.4 g of turmeric powder and 4 g of sea salt were added.

2. Tomato fruit mixture (T2): 82.44 g of fresh tomato fruits were cut and hand crushed for 60 times. The crushed fruit was rinsed with 5 mL of water.

3. Spice mixture (T3): 1.33 g of pepper drupes was crushed in an SS 316 mortar and pestle for 85 times. 2.67 g of cumin fruits was added over to the crushed pepper drupes and crushed for 100 times. To the above-crushed mixture, 0.82 g of chili pepper was added and crushed for 50 times; then, 9.63 g of garlic cloves was added and crushed for 90 times.

4. All mixture (T4): Tomato fruit mixture (T2) was rinsed with 10 mL of water and spice mixture (T3) was rinsed with 10 mL of water. Both rinsing were added to tamarind fruit pulp mixture (T1), which was designated as sample RS1.

5. Final product (T5): 4 mL of Indian sesame oil was heated at 60°C for 2 min. After 5 seconds 0.82 g of mustard seeds were added. After 3 s, 1.53 g of whole chili pepper was added. After 2 s, 0.61 g of curry leaves was added, which was designated as sample RS2. Immediately, all mixture (T4) was rinsed with 20 mL of water and added. The whole liquid was allowed to boil for 5 min. After 5 min, 1.50 g of coriander leaves was added; this was designated as sample RS3. When the liquid frothed, 0.05 g of asafetida was added and the heating was switched off to yield the final product, which was designated as sample RS4.

The stage-wise samples RS1, RS2, RS3, and RS4 in the preparation of rasam were studied to evaluate the significance of the traditional processing.

**Cytotoxicity study**

Cytotoxicity was studied by brine shrimp lethality bioassay as per the method of Meyer et al., 1982.\textsuperscript{[10]} Brine shrimps (Artemia salina) were hatched from eggs in a conical-shaped vessel (1 L), filled with artificial seawater (prepared using sea salt 38 g/L and adjusted to pH 8.5 using 1 N NaOH) with constant aeration for 36 h at room temperature (20°C ± 5°C) under light. After hatching, active nauplii, free from egg shells, were collected from brighter portion of the hatching chamber and used for the assay. Ten nauplii were drawn through a glass capillary and placed in vials each containing 4.5 mL of brine solution (24% of NaCl in water). In every vial, 0.5 mL of water or sample was added to the brine solution and maintained at room temperature (20°C ± 5°C) under light. The number of surviving nauplii after 24 h was counted. Experiments were conducted at different concentrations (20, 40, 80, 120, 160, 200, and 400 µL/mL) of the samples (RS1, RS2, RS3, and RS4) diluents being water. Each concentration of the sample was studied in six vials along with a control group.

The % lethality was determined from the number of surviving nauplii in control and sample using the below-mentioned formula.

\[
\text{Control} = \frac{\text{Control - Sample}}{\text{Control}} \times 100
\]

Control is number of surviving nauplii in control, and sample is number of surviving nauplii in sample. LC\textsubscript{50} values were calculated from percentage lethality versus concentration best-fit line graph.

**Antimitotic study**

Antimitotic study was studied by onion root tip inhibition assay as per the method of Rai et al., 2007.\textsuperscript{[11]} The old roots of Allium cepa bulbs (56.46 ± 4.14 g; values are expressed as mean ± standard deviation (SD)) were removed and grown in the dark over a small beaker containing 35 mL of tap water (the water was changed every 24 h) at 20°C ± 5°C until the root tips have grown to approximately 2–3 cm (in approximately 2–3 days). The bulbs with root tips grown up to 2–3 cm were selected. Ten root tips grown above 2 cm were kept as such, and rest of them were trimmed off. The bulbs with only 10 root tips were placed over water or sample solutions, and incubation was carried out at 20°C ± 5°C. Samples RS1, RS3, and RS4 each at a concentration of 1, 10, 100, and 200 µL/mL were studied in triplicate. The oil sample (RS3) would form a layer on the surface and never allow the growth of the root tip; hence, RS3 was omitted for this study.

In each bulb, root length and newly grown root tips were recorded at 0, 24, 48, and 72 h. One root in each bulb was cut using a scalpel between 8.00 to 13.00 h IST at 0, 24, 48, and 72 h. Extreme root tips (2–3 mm) of root were cut and put in a test tube containing water. The test tube was
treated with 1.5 mL of 0.1 N HCl and incubated at 60°C for 12 min. The 0.1 N HCl was drained and the root tips were washed with water 4 times to remove the acid traces. Then, five drops of aceticarmine was added and incubated at 60°C for 24 min. The red turned root tip was transferred to a clean glass slide and a cover slip was placed over. Very gentle pressure was applied with thumb over the cover slip to provide uniform spread of the cells. The number of mitotic and total meristematic cells was counted in 5–6 fields using high power (×100) light microscope. For control and all samples, 500 cells were counted and cells manifesting different stages of mitosis, i.e., interphase and prophase (P), metaphase (M), anaphase (A), and telophase (T), were recorded. The mitotic index at 0, 24, 48, and 72 h was calculated using the following formula.

Mitotic index = \[
\frac{(P + M + A + T)}{(Total \ number \ of \ cells)} \times 100
\]
P, M, A, and T is prophase, metaphase, anaphase, and telophase, respectively.

IC_{50} values were calculated from the concentration versus percentage of inhibition best-fit line graph. The values are expressed as mean ± SD. GraphPad Instat Version 4 software (GraphPad Software, USA) was used. Data were subjected to the one-way analysis of variance to determine the significance of changes followed by Dunnett’s multiple comparisons.

### RESULTS AND DISCUSSION

Brine shrimp lethality assay is a rapid, reliable and has been used for over 30 years in cytotoxic, phototoxic, pesticidal, trypanocidal, enzyme inhibition, and ion regulation activities.\(^\text{(14)}\) The nauplii after hatching at 0 and 24 h are shown in Figure 1. RS4, the final product of rasam, showed high lethality (38.7 µL/mL) than RS1 (165.6 µL/mL), RS2 (387.6 µL/mL), and RS3 (124.2 µL/mL) [Table 1]. The percentage of lethality was found to be directly proportional to the concentration of the samples. Stage-wise preparation analysis shows 3.2-fold increase of cytotoxicity in RS4 as compared to of RS1, RS2, and RS3. It is evident that the process in preparation of rasam plays an important role in increasing the physiological action of the final product (RS4). Brine shrimp lethality bioassay has good correlation with the human solid tumor cell lines;\(^\text{(15)}\) hence, it can be suggested that the sample RS4 is bioactive, with cytotoxic and antitumor activity.

Most of the plant-derived anticancer drugs affect the microtubule dynamics of the cell and induce persistent modification of biological processes and signaling pathways that ultimately lead to apoptotic death.\(^\text{(16)}\) Onion root tip inhibition assay is a quick, efficient, simple but sensitive antimitotic bioassay and also known to give a similar result to the in vitro animal cytotoxicity test.\(^\text{(17)}\) The study showed that at 72 h, RS1, RS3, and RS4 at all concentrations (1, 10, 100, and 200 µL/mL) significantly inhibits root growth [Table 2]. Figure 2 shows the effect of RS1 (200 µL/mL), RS3 (200 µL/mL), and RS4 (200 µL/mL) on root tip growth at 72 h in comparison to the control group. It is evident that all samples affect cell division in long duration. There was no increase in root length for RS1 (200 µL/mL) and RS3 (200 µL/mL) after 24 h. The final product RS4 at 200 µL/mL showed no increase in root length even after 0 h, suggesting maximum root inhibition. RS3 (200 µL/mL) and RS4 (100 and 200 µL/mL) significantly prevented the growth of new root tips after 0 h [Table 2]. However, after 72 h, all samples at different concentrations also significantly inhibited the growth of new root tips. RS4 (200 µL/mL) not only significantly inhibits the root length but also prevents the growth of a new root tip after 0 h. The number of cells in prophase was nearly double the metaphase in RS1, RS3, and RS4 treated groups. The number of cells in telophase varied from 9 to 12 within the counted 500 cells of all sample-treated groups. The number of dividing cells the mitotic index clearly confirms that RS4 (200 µL/mL) at 24 h significantly inhibits mitosis [Table 3].

\[ IC_{50} \text{ value (189.86 µL/mL) of the final product of RS4 (rasam) only confirms maximum inhibition of mitosis in a dose-dependent manner compared to RS1 and RS3 (Table 3), and also, the IC}_{50} \text{ value of RS4 was found to be 2.2 times lower than its constituents (RS1 and RS3). Antitumor drugs that interact with microtubules and tubulin are known to block mitosis and induce cell death by apoptosis.} \]
Table 1: The lethality effect of RS1, RS2, RS3, and RS4 on brine shrimps

| Control/sample | Concentration | Number of nauplii at 0 h | Number of surviving nauplii after 24 h | Percentage lethality | LC50 (µL/mL) |
|----------------|---------------|--------------------------|-----------------------------------------|----------------------|--------------|
| Water          | 0.1 mL/mL     | 60                       | 60                                      | 0                    | NA           |
| RS1            | 20 µL/mL      | 60                       | 58                                      | 3.3                  | 165.6        |
|                | 40 µL/mL      | 60                       | 51                                      | 15.0                 |              |
|                | 80 µL/mL      | 60                       | 41                                      | 31.7                 |              |
|                | 120 µL/mL     | 60                       | 38                                      | 36.7                 |              |
|                | 160 µL/mL     | 60                       | 31                                      | 48.3                 |              |
|                | 200 µL/mL     | 60                       | 27                                      | 55.0                 |              |
|                | 400 µL/mL     | 60                       | 16                                      | 73.3                 |              |
| RS2            | 20 µL/mL      | 60                       | 59                                      | 1.7                  | 387.6        |
|                | 40 µL/mL      | 60                       | 56                                      | 6.7                  |              |
|                | 80 µL/mL      | 60                       | 53                                      | 11.7                 |              |
|                | 120 µL/mL     | 60                       | 51                                      | 15.0                 |              |
|                | 160 µL/mL     | 60                       | 47                                      | 21.7                 |              |
|                | 200 µL/mL     | 60                       | 44                                      | 26.7                 |              |
|                | 400 µL/mL     | 60                       | 29                                      | 51.6                 |              |
| RS3            | 20 µL/mL      | 60                       | 47                                      | 21.7                 | 124.2        |
|                | 40 µL/mL      | 60                       | 43                                      | 28.3                 |              |
|                | 80 µL/mL      | 60                       | 37                                      | 38.3                 |              |
|                | 120 µL/mL     | 60                       | 31                                      | 48.3                 |              |
|                | 160 µL/mL     | 60                       | 26                                      | 56.7                 |              |
|                | 200 µL/mL     | 60                       | 20                                      | 66.7                 |              |
|                | 400 µL/mL     | 60                       | 11                                      | 81.7                 |              |
| RS4            | 20 µL/mL      | 60                       | 36                                      | 40.0                 | 38.7         |
|                | 40 µL/mL      | 60                       | 29                                      | 51.7                 |              |
|                | 80 µL/mL      | 60                       | 20                                      | 66.7                 |              |
|                | 120 µL/mL     | 60                       | 13                                      | 78.3                 |              |
|                | 160 µL/mL     | 60                       | 9                                       | 85.0                 |              |
|                | 200 µL/mL     | 60                       | 4                                       | 93.3                 |              |
|                | 400 µL/mL     | 60                       | 0                                       | 100                  |              |

NA: Not available

Table 2: Effect of RS1, RS3, and RS4 on onion root tip growth at 72 h

| Control/sample | Concentration | Root length (cm) | Total number of newly grown root tip at 0 h | 24 h | 48 h | 72 h |
|----------------|---------------|------------------|---------------------------------------------|------|------|------|
|                |               | (n=30)           |                                             | (n=27)| (n=24)| (n=21)|
| Water          | 1 mL/mL       | 2.46±0.20        | 5.02±0.32                                   | 6.41±0.43 | 10.33±1.53 | 14.33±0.58 | 22.67±0.58 |
| RS1            | 1 µL/mL       | 2.31±0.17        | 4.78±0.35                                   | 5.51±0.30** | 9.67±1.53 (NS) | 13.67±0.58 (NS) | 21.67±1.16 (NS) |
|                | 10 µL/mL      | 2.43±0.18        | 4.36±0.28                                   | 5.12±0.32** | 9.33±0.58 (NS) | 12.67±1.16 (NS) | 20.33±0.58** |
|                | 100 µL/mL     | 2.54±0.17        | 3.67±0.38                                   | 4.02±0.27** | 8.67±0.58 (NS) | 11.33±1.16** | 18.67±0.58** |
|                | 200 µL/mL     | 2.44±0.17        | 2.90±0.30                                   | 2.92±0.25** | 8.33±0.58 (NS) | 8.67±1.16** | 8.67±1.16** |
| RS3            | 1 µL/mL       | 2.41±0.16        | 3.52±0.23                                   | 4.29±0.35** | 9.33±1.53 (NS) | 12.33±0.58 (NS) | 20.67±0.58* |
|                | 10 µL/mL      | 2.31±0.16        | 2.71±0.36                                   | 3.28±0.20** | 9.33±0.58 (NS) | 11.33±0.58** | 18.67±0.58** |
|                | 100 µL/mL     | 2.35±0.18        | 2.49±0.18                                   | 3.85±0.20** | 8.33±0.58 (NS) | 8.33±0.58** | 8.33±0.58** |
|                | 200 µL/mL     | 2.59±0.25        | 2.58±0.26                                   | 3.58±0.26** | 7.33±1.16** | 7.33±1.16** | 7.33±1.16** |
| RS4            | 1 µL/mL       | 2.57±0.22        | 3.46±0.20                                   | 4.93±0.16** | 8.33±1.53 (NS) | 9.67±1.53 (NS) | 12.33±0.58** |
|                | 10 µL/mL      | 2.46±0.19        | 3.25±0.28                                   | 4.02±0.26** | 8.33±0.58 (NS) | 8.33±0.58** | 8.33±0.58** |
|                | 100 µL/mL     | 2.53±0.25        | 2.60±0.27                                   | 2.58±0.28** | 1.67±1.58** | 1.67±0.58** | 1.67±0.58** |
|                | 200 µL/mL     | 2.48±0.18        | 2.48±0.19                                   | 2.46±0.20** | 0.33±0.58** | 0.33±0.58** | 0.33±0.58** |

Values are expressed as mean±SD; *P<0.05; **P<0.01; NS (P>0.05). NS: Not significant; SD: Standard deviation.
Table 3: Effect of RS1, RS3, and RS4 on total number of dividing cells, mitotic index at 0, 24, 48, and 72 h, and their IC_{50} values after 72 h

| Control/sample | Concentration (µL/mL) | Cells manifesting different stages of mitosis | Mitotic index | Percentage of inhibition at 72 h | IC_{50} (µL/mL) |
|---------------|-----------------------|-----------------------------------------------|---------------|---------------------------------|----------------|
|               | 0 h                   | 24 h                                           | 48 h          | 72 h                            |                |
| Water         | 1 mL                  | 252.33±11.02                                  | 247.67±10.26  | 248.67±17.50                    | 243.67±14.30  |
|               | 10 µL                 | 243.33±6.51                                  | 252.67±20.79  | 238.87±10.50                    | 238.67±10.50  |
|               | 100 µL                | 248.67±7.02                                  | 250.67±13.58  | 228.67±9.29                     | 228.67±9.29   |
| RS1           | 1 µL                  | 248.67±13.08                                  | 247.33±5.03   | 226.33±21.50                    | 216.33±10.60  |
|               | 10 µL                 | 252.33±6.51                                  | 252.67±7.64   | 246.33±14.50                    | 244.67±14.57  |
|               | 100 µL                | 244.67±11.72                                  | 235.33±13.58  | 231.33±5.86                     | 227.67±8.31   |
| RS3           | 1 µL                  | 256.67±10.02                                  | 223.67±9.29   | 216.33±4.73                     | 214.33±5.03   |
|               | 10 µL                 | 242.33±14.05                                  | 219.67±14.98  | 206.33±6.60                     | 206.33±4.51   |
|               | 100 µL                | 251.33±12.01                                  | 247.67±12.66  | 236.33±13.66                    | 232.67±8.08   |
| RS4           | 1 µL                  | 254.67±7.37                                  | 231.33±11.72  | 164.33±7.64                     | 142.67±10.41  |
|               | 10 µL                 | 237.33±1.68                                  | 203.33±8.51   | 132.67±9.71                     | 113.33±6.81   |
|               | 200 µL                |                                             |               |                                 |                |

*Percentage of inhibition and IC_{50} values are expressed as mean±SD; *P<0.05; **P<0.01; NS: Not significant; SD: Standard deviation

Total number of cells counted was 500; values are expressed as means±SD; *P<0.05; **P<0.01; NS: Not significant; SD: Standard deviation

Table 4: Percentage of inhibition and IC_{50} values of RS1, RS2, RS3, and RS4 in MCF-7, HeLa, and Calu-6 cell lines

| Samples | Concentration (µL/mL) | MCF-7 cell lines | HeLa cell lines | Calu-6 cell lines |
|---------|-----------------------|------------------|-----------------|-------------------|
|         |                       | ABS at 590 nm    | Percentage of inhibition | IC_{50} (µL/mL) | ABS at 590 nm | Percentage of inhibition | IC_{50} (µL/mL) | ABS at 590 nm | Percentage of inhibition | IC_{50} (µL/mL) |
| Control | -                     | 0.7368           | 0               | 0                 | 0.5568        | 0                 | 0               | 0.7632           | 0                 | 0                 |
| RS1     | 166.67                | 0.6079           | 17.50           | >500              | 0.4912        | 11.78             | >500            | 0.6574           | 13.86             | >500              |
|         | 200                   | 0.5897           | 19.97           |                   | 0.4717        | 15.28             |                 | 0.6203           | 18.72             |
|         | 250                   | 0.5468           | 25.79           |                   | 0.4543        | 18.41             |                 | 0.5558           | 27.18             |
|         | 333.33                | 0.5121           | 30.50           |                   | 0.3957        | 28.93             |                 | 0.5343           | 29.99             |
|         | 500                   | 0.4826           | 34.50           |                   | 0.3727        | 33.06             |                 | 0.5012           | 34.33             |
| RS2     | 166.67                | 0.5961           | 19.10           | >500              | 0.4779        | 14.17             | >500            | 0.6687           | 12.38             | >500              |
|         | 200                   | 0.5758           | 21.85           |                   | 0.4488        | 19.40             |                 | 0.6427           | 15.79             |
|         | 250                   | 0.5517           | 25.12           |                   | 0.4072        | 26.87             |                 | 0.6198           | 18.79             |
|         | 333.33                | 0.5281           | 28.33           |                   | 0.3631        | 34.79             |                 | 0.5958           | 21.93             |
|         | 500                   | 0.5017           | 31.91           |                   | 0.3245        | 41.72             |                 | 0.5524           | 27.62             |
| RS3     | 166.67                | 0.5996           | 18.62           | >500              | 0.4687        | 15.82             | >500            | 0.5779           | 24.28             | >500              |
|         | 200                   | 0.5682           | 22.88           |                   | 0.4427        | 20.49             |                 | 0.5488           | 28.09             |
|         | 250                   | 0.5417           | 26.48           |                   | 0.4198        | 24.60             |                 | 0.5072           | 33.54             |
|         | 333.33                | 0.5101           | 30.77           |                   | 0.3958        | 28.92             |                 | 0.4631           | 39.32             |
|         | 500                   | 0.4814           | 34.66           |                   | 0.3524        | 36.71             |                 | 0.4245           | 44.38             |
| RS4     | 166.67                | 0.5562           | 24.51           | 350.22            | 0.4892        | 12.14             | >500            | 0.6452           | 15.46             | 410.15            |
|         | 200                   | 0.5303           | 28.03           |                   | 0.4565        | 18.01             |                 | 0.6605           | 20.73             |
|         | 250                   | 0.4982           | 32.38           |                   | 0.4224        | 24.14             |                 | 0.5894           | 22.77             |
|         | 333.33                | 0.3843           | 47.84           |                   | 0.4020        | 27.80             |                 | 0.4663           | 38.90             |
|         | 500                   | 0.3125           | 57.59           |                   | 0.3786        | 32.00             |                 | 0.3611           | 52.69             |

ABS: Absorbance
exhibited antimitotic activity of RS4 may be due to its interaction with microtubules. RS4 showed an IC₅₀ value of 350.22 and 410.15 µM/mL in MCF-7 and Calu-6 cell lines, respectively [Table 4]. RS1, RS2, and RS3 showed an IC₅₀ value more than 500 µM/mL in MCF-7, HeLa, and Calu-6 cell lines, respectively. The results showed that the final product RS4 may be active against breast and lung cancers. However, the mechanism for such an effect needs further evaluation.

The postmodern “preventive medicine” concept of the Western medicine has absolutely recognized that food plays an important role in the incidence of many diseases. Dietary choice remains the basis for maintaining a healthy lifestyle and well-being, especially relating to cardiovascular disease, diabetes, obesity, hypertension, some cancers, circulatory diseases, and stroke, despite remarkable advances in medicine and pharmaceutical drug development.[23,24,25] According to the National Cancer Registry Programme of the India Council of Medical Research, more than 13,000 Indians die every day due to cancer. Between 2012 and 2014, the mortality rate due to cancer increased by approximately 6%. The risk of cancer incidence may also be due to the deviation from traditional functional food toward fast, junk, and westernized foods.

The different ingredients used in rasam have been individually attributed to various pharmacological effects in preclinical and clinical studies. It is trouble-free to ascertain that the rasam’s effects are due to the antioxidant effect of tamarind fruit pulpy[26,27] antitoxic and antiarcanogenic effect of turmeric,[28,29] antioxidant and anticancer activity of chili pepper,[30] antioxidant activity of cumin;[31] anticancer and antioxidant effects of garlic bulbs,[32,33] antioxidant and bioavailability enhancing effect of black pepper,[34,35] and antioxidant activity of coriander leaves.[36] However, if all ingredients and/or active constituents of rasam were scientifically formulated together using available technology, it may not yield the desired physiological result; however, somehow in the preparation of rasam, the traditional processing naturally ensures higher cytotoxic, antimitotic, and antiproliferation activity in the final product. The LC₅₀ and IC₅₀ values of rasam may not be very significant compared to active pharmaceutical agents that are administered in a fixed dose but consuming rasam as daily diet can ensure healing effect. The real challenge lies not in proving whether rasam is functional foods having health benefits, but in defining what these benefits are and developing the methods to expose them by scientific means.

CONCLUSION

Rasam is a South Indian traditional functional food that can treat breast and lung cancer on chronic use.

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Conflicts of interest

There are no conflicts of interest.

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