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# Development of healthier meatballs using walnut kernels and fat modifications

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## ABSTRACT

The current study was aimed at optimizing the amount of fat and walnut kernel content for the production of functional meatballs (locally called as *Rista*). In the first experiment, different combinations of lean meat, animal fat, and vegetable fat (T1 = 90% lean meat: 10% animal fat; T2 = 90% lean meat: 5% animal fat: 5% vegetable fat; T3 = 90% lean meat: 10% vegetable fat) were compared to control (T0 = 80% lean meat: 20% animal fat). Based on physicochemical, proximate, antioxidant activity parameters and sensory scores, T1 (90% lean meat: 10% animal fat) was found optimum for the formulation of functional meatballs. In the second experiment, walnut kernel paste (WKP) was incorporated at three levels (3, 6, and 9%) replacing lean meat in the formulation of gravy-based products. 6% WKP was found optimum for the development of functional meatballs. It was concluded that the formulation containing 84% lean meat, 10% animal fat, and 6% walnut kernel paste was suitable for the preparation of functional meatballs.

**Key words:** Antioxidant activity, TBARS, texture profile, *Rista*, water activity, meatballs, functional.

# INTRODUCTION

Humans have been consuming meat for ages as it contains valuable amounts of high- quality proteins, fatty acids, vitamins, minerals, micronutrients, fats and other bioactive compounds (Bagona *et al*., 2013). It is also a source of many health-promoting components such as conjugated linoleic acid (CLA), iron, zinc, selenium, L-carnitine, histidyl dipeptides, creatine, taurine, glutathione, etc. (McAfee *et al*., 2010). According to 20$^{th}$ Livestock Census, the total livestock population in India was 535.78 million, of which sheep contributed 74.26 million (13.87%) of the total livestock population. The total meat production in India was found to be 9.29 MT, of which sheep meat share is 10.33 percent (DAHD, 2023).

India being a conglomerate of several cultures and traditions is home to many ethnic meat products. Ethnic meat products are high sensory quality foods, with high nutritional value and are produced on a small scale by using ingredients and procedures from ancient times. They are generally popular locally in a particular geographical area. *Wazwan* is the famous cuisine of Kashmir Valley. The term *Wazwan* has been derived from two Kashmiri words i.e. "*waza*" meaning chef/cook and "*wan*" meaning shop.

*Rista* is an inseparable emulsion-based comminuted meatball, a product of wazwan. Traditionally, a considerable amount of fat (about 20-30%) is used in the formulation of *Rista* to achieve a stable emulsion and also to impart a special taste and flavour to the product which has raised concerns among the health-conscious consumers that necessitated the need to reduce and/or replace the total fat content in this product. The overall product functionality can be improved in various ways like fat profile modification such as increasing healthy fats (omega 3 fatty acids etc) and addition of other health-improving components (Zhang *et al*., 2010).

Walnut kernels contain 4% water, 15% protein, 65% fat (mostly omega fats), 14% carbohydrates and 7% dietary fiber (Sen and Karadeniz, 2015). Since walnuts are rich source of many phytochemical substances which have antioxidant effects and can also prevent ageing, cancers, inflammations, and neurologic illnesses (Sen and Karadeniz, 2015), the incorporation in *Rista* could prove beneficial in enhancing its functional value. Thus, current study was envisaged to optimize the fat content and walnut kernel paste level in the formulation of functional meatballs (*Rista*).

# MATERIALS AND METHODS

Lean meat obtained from hind leg portions of the freshly dressed sheep carcasses (12-18 months old male animal) was used along with animal fat and other ingredients for the preparation of meatballs. Table salt, vegetable oil, and walnut kernels used in product preparation were procured from the local market as per requirement. Walnut kernels were ground in a grinder to form a fine paste needed for product preparation.

Mutton chunks and mutton fat were minced separately through 8 mm plate in a meat mincer. The required quantity of minced meat was placed in the bowl chopper and chopping was done for 1 minute. To this, 2.5% table salt was added and chopping was continued for further 1 minute after which minced mutton fat was added and chopping was continued for 2 minutes. At this stage, 10% chilled water was added and again chopping was done for 2 minutes. Large cardamom seeds and walnut kernel paste were added towards the end and chopping was continued for further 1-2 minutes to obtain an emulsion of desirable quality. The emulsion was moulded in the shape of spherical balls and were kept under refrigeration for half an hour and cooked in their respective gravies. The core temperature of meatballs was recorded by using a probe thermometer, which showed a core temperature of 72°C at the end of the cooking process. The cooked product along with the gravy was cooled to room temperature and analysed for different parameters.

## Analytical procedures

The pH of the cooked samples was determined as per the method of Trout *et al.* (1992) by using a digital pH meter (Model CP 901, Century Instruments Ltd., and India). The emulsion stability of the raw emulsion was determined as per the method of Baliga and Madaiah (1970) by taking 25g of raw emulsion from each treatment in duplicate and placed in LDPE bags. The bags were sealed and weighed. The cooked samples (80°C for 20 minutes) were allowed to cool down. The samples were weighed and loss in weight was expressed in percentage as an index of emulsion stability. The cooking yield was calculated and expressed in percentage by recording individual weights of *Rista* balls before and after cooking. The percentage moisture, protein, fat and ash content of the product samples were evaluated as per the standard procedure of AOAC (2019) using a hot air oven, kjeldahl assembly, soxhlet extraction apparatus and muffle furnace, respectively.

Colour was determined as per the method of Hunter and Harold (1987) by using a Hunter Lab Colorimeter (Model SN 3001476, Accuracy Micro Sensors, New York). Readings were displayed as L*, a*, b* colour parameters according to the CIELAB system of colour measurement. The estimation of texture profile was evaluated by following the procedures as described by Bourne (1978). The parameters were measured using a TA-XT2 Texture Analyzer (Perkin Elmer Private Limited, Godalming, Surrey UK) with a 35 mm diameter cylindrical flat probe. A 5 kg load cell was used to carry out the test. The testing conditions were kept as – pre-test speed-1mms$^{-}$1; post-test speed – 10mms$^{-1,}$ test speed – 3mms$^{-1}$, trigger force – 50N and travel distance of the probe was kept as 5mm.

The DPPH (1, 1- diphenyl-2- picrylhydrazyl) assay was done according to the method of Brand-Williams *et al* (1995) with slight modifications. The stock solution was prepared by dissolving 24 mg DPPH with 100 ml methanol and then stored at - 20$^{o}$ C until needed. The working solution was obtained by mixing 10 ml of stock solution with 45 ml methanol to obtain an absorbance of 1.1±.02 units at 515 nm using the spectrophotometer. 150 µl of meat extract was allowed to react with 2850 µl of the DPPH solution for 24 hours in the dark. Absorbance was taken at 515 nm. The ABTS (2, 2-azinobis-3 ethylbenthiazoline-6-sulphonic acid) assay was done according to the method of Re *et al* (1999) with slight modifications. The stock solution was prepared by measuring 7.0 mM ABTS solution and 2.45 mM potassium persulphate solution.

The working solution was obtained by mixing two stock solutions in equal quantities and allowing them to react for 16 hours at room temperature in the dark. The solution was then diluted by mixing 1 ml ABTS with 40 ml methanol to obtain an absorbance of 1.1±.02 units at 734 nm using the spectrophotometer. 150 µl of meat extract was allowed to react with 2850 µl of the ABTS solution for 2 hours in the dark and absorbance was taken at 734 nm.

The sensory evaluation of the products and their gravies were conducted according to the method of Keeton *et al.* (1983) wherein the product chunks in their respective gravies were served hot to the panelists comprising of scientists and postgraduate students of the Division of Livestock Products Technology, Shuhama. The product samples and their gravies were evaluated for various sensory parameters viz. appearance, flavour, texture, juiciness, consistency, binding, saltiness, mouth coating, and overall acceptability using an 8-point descriptive scale, where 8 is extremely desirable and 1 is extremely undesirable. Plain water was provided to the panelists to rinse the mouth at intervals between the samples.

The data generated was analysed statistically using the software of Statistical Package for Social Sciences (SPSS-Base 20.0). Analysis of variance by one-way and independent t-Test was computed and the significance of mean was tested at a 5% level of significance.

# RESULTS AND DISCUSSION

## Optimization of fat content in Rista (meatballs cooked in gravy)

The emulsion stability and cooking yield of $T_0$ was significantly (P<0.05) higher than $T_2$ and $T_3$ but comparable with $T_1$. Among the treatment groups, emulsion stability values decreased significantly (P<0.05). $T_1$ had higher emulsion stability which might be due to the holding and entrapping of moisture (because of more protein content than other treatments) during the application of heat. The higher cooking yield in $T_1$ might be due to better binding in comparison with $T_0$, $T_2$ and $T_3$. Our results are in agreement with the findings of Choi *et al.* (2009) who reported a decrease in the emulsion stability of low-fat frankfurters prepared by replacing pork fat with olive oil, grapeseed oil, corn oil, canola oil, and soybean oil. There was no significant difference (P>0.05) in the pH among the treatments.

A significant (P<0.05) increase in the moisture content was found among the treatments which could be attributed to decreasing solids. The results are in contrast with Turp and Serdaroglu (2007) who reported a decrease in the moisture content of sucuk samples when beef fat was replaced with hazelnut oil. There was a significant difference (P<0.05) in the protein content among the treatments. Higher protein content in $T_1$ might be attributed to more lean meat percentage in the product formulation. Turp and Serdaroglu (2007) found decreased protein content in sucuk with 15% of beef fat replaced with hazelnut oil.

$T_0$ showed increased fat content which could be attributed to more amount of fat used in it. In $T_2$ and $T_3$, fat content decreased which is due to poor binding in the product by the incorporation of vegetable oil. Choi *et al.* (2009) found a decrease in the fat content of reduced- fat frankfurters containing olive oil, grapeseed oil, corn oil, canola oil, and soybean oil.

The sensory attributes of $T_1$ were comparable with $T_0$. $T_2$ and $T_3$ showed significantly (P<0.05) lower scores as compared to $T_0$ and $T_1$. Choi *et al.* (2010) reported that the sensory attributes were comparable between the control sample and the treatments when pork back fat was replaced with vegetable oils and rice bran fiber.

**Table 1:** Effect of fat optimization on the physicochemical quality and compositional quality of *Rista* (Mean ± S.E.)

| Parameters(on % basis except pH) | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Emulsion stability | $87.49±0.59^{c}$ | $87.77±0.44^{c}$ | $85.50±0.59^{b}$ | $82.20±0.03^{a}$ |
| Cooking yield | $88.09±0.93^{c}$ | $88.84±0.69^{c}$ | $86.52±0.48^{b}$ | $84.21±0.02^{a}$ |
| pH | 6.24± 0.02 | 6.29 ± 0.03 | 6.28 ± 0.03 | 6.26 ± 0.03 |
| Moisture | $63.07±0.17^{a}$ | $71.62±0.17^{b}$ | $73.45±0.00^{c}$ | $76.23±0.00^{d}$ |
| Protein | $15.32±0.00^{c}$ | $16.22±0.00^{d}$ | $15.01±0.00^{b}$ | $14.82±0.00^{a}$ |
| Fat | $17.21±0.00^{d}$ | $8.78 ±0.17^{c}$ | $7.62 ±0.17^{b}$ | $6.61 ±0.17^{a}$ |
| Ash | $2.40±0.02^{a}$ | $2.48 ±0.02^{b}$ | $2.45±0.02^{ab}$ | $2.43±0.02^{ab}$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 6 except for cooking yield and emulsion stability in which N = 3

**Table 2:** Effect of fat optimization on the sensory quality of *Rista* (Mean ± S.E.)

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Appearance | 7.67 ± 0.126$^c$ | 7.67 ± 0.126$^c$ | 6.80 ± 0.107$^b$ | 6.00±0.258$^a$ |
| Flavour | 7.53±0.133$^c$ | 7.33 ± 0.126$^c$ | 6.67 ± 0.126$^b$ | 6.20±0.175$^a$ |
| Juiciness | 7.73 ± 0.118$^c$ | 7.47 ± 0.133$^c$ | 6.73 ± 0.118$^b$ | 5.73±0.118$^a$ |
| Texture | 7.60 ± 0.131$^c$ | 7.47 ± 0.133$^c$ | 6.67 ± 0.126$^b$ | 5.73±0.118$^a$ |
| Mouth coating | 7.33 ± 0.126$^b$ | 7.40 ± 0.131$^b$ | 6.60 ± 0.131$^a$ | 6.40±0.131$^a$ |
| Binding | 7.33 ± 0.126$^c$ | 7.40 ± 0.131$^c$ | 6.20 ± 0.107$^b$ | 5.53±0.133$^a$ |
| Saltiness | 7.33 ± 0.126 | 7.40 ± 0.131 | 7.27 ± 0.118 | 7.40±0.131 |
| Overall acceptability | 7.67 ± 0.126$^c$ | 7.67 ± 0.126$^c$ | 6.67 ± 0.126$^b$ | 5.87±0.133$^a$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 15

## Optimisation of walnut kernel paste in the formulation of Rista (meatballs cooked in gravy)

The emulsion stability value of control ($T_0$) was significantly (P<0.05) higher than $T_2$ and $T_3$ but comparable to $T_1$. The lowered emulsion stability might be due to the interference of walnut paste in the proper emulsification of fats, which resulted in decreased binding in the products. The findings are however not in agreement with Rovida *et al.* (2018) who found increased emulsion stability of mutton nuggets with an increase in levels of WKP. There was a decrease in the cooking yield with an increase in the levels of walnut kernel paste. The cooking yield values of *Rista* were affected by the use of WKP and a decreasing trend was observed. The slight decrease in the cooking yield of both products might be due to the lowered emulsion stability caused by the addition of WKP. The findings are in agreement with Salejda *et al.* (2016) who reported a decrease in the cooking yield of cooked sausages with the addition of walnut green husk.

Among the treatment groups, pH values increased significantly (P<0.05) with an increase in the levels of walnut kernel paste incorporation. The increase in the pH might be attributed to the higher pH of the walnut kernels (pH=7) as compared to the raw lean meat (pH=5.7-6). The results are in agreement with those of Serrano *et al.* (2005) and Rovida *et al.* (2018) who reported that the addition of walnuts caused a significant (P<0.05) increase in the pH values of cooked steaks and mutton nuggets, respectively.

The moisture values of *Rista* decreased with the increasing levels of WKP incorporation which might be attributed to decreased emulsion stability with an increase in level of WKP, hence less moisture retention. The results are in agreement with Ayo *et al.* (2008) who reported that the walnut-added frankfurters contained the lowest moisture content than low-fat frankfurters. The protein values of *Rista* decreased with the increasing levels of WKP incorporation which could be attributed to the lower protein content of walnut kernels as compared to the lean meat. The results are in agreement with Serrano *et al.* (2005) who found decreased protein content with the addition of walnuts in restructured beef steaks. The fat values of *Rista* increased with the increasing levels of WKP incorporation. Similar results were found by Serrano *et al.* (2005) by the addition of walnuts in restructured beef steaks. The ash content values of *Rista* were not affected by the use of WKP though an increasing trend was observed. Similar findings are reported by Ayo *et al.* (2008) who concluded that the addition of walnuts raised the ash level in frankfurters.

The DPPH and ABTS assay values of *Rista* increased with the increasing levels of WKP incorporation which might be attributed to the addition of antioxidant-rich walnut kernel paste in *Rista*. The results were found in agreement with Colmenero *et al.* (2010) who reported that regular consumption of meat products containing walnuts cause improvement in antioxidant status and a reduction in thrombogenesis markers. Singh *et al.* (2014) also reported an increase in DPPH-RSA and ABTS-RSA values in raw chicken meat emulsion incorporated with clove powder, ginger, and garlic paste.

The hardness values of *Rista* decreased with the increasing levels of WKP incorporation which might be due to lesser binding due to the addition of walnut kernel paste. The cohesiveness values of *Rista* increased with the increasing levels of WKP incorporation. Choi *et al.* (2009) also observed an increase in cohesiveness after the addition of vegetable oils in an emulsified meat system with nano-emulsion. The springiness values of *Rista* increased with the increasing levels of WKP incorporation which might be due to an increase in elasticity by incorporation of WKP. The gumminess values of *Rista* decreased with the increasing levels of WKP incorporation which could be attributed to the loss of proteins in the emulsion. The chewiness values of *Rista* decreased with the increasing levels of WKP incorporation which could be attributed to the loss of proteins in the emulsion. The results are in agreement with Pycia and Ivanisova (2020) who reported similar results in wheat bread due to the enrichment with walnuts.

The lightness values of *Rista* decreased with the increasing levels of WKP incorporation which might be due to the addition of dark brown walnut kernel paste. The redness (a) values of *Rista* decreased with the increasing levels of WKP incorporation which could be due to the reduction in the red colour of meat with the addition of walnut kernels containing brownish colour pigments as antioxidants. The yellowness (b) values of *Rista* decreased with the increasing levels of WKP incorporation which might be due to the addition of dark brown walnut kernels. The results corroborate with the results of Boruzi and Nour (2019) who reported similar results in cooked pork patties enriched with walnut leaf powder.

The sensory panelists did not detect any major differences among the products. Appearance, juiciness, texture, mouth coating, binding, saltiness, and overall acceptability decreased in *Rista* treated with WKP as compared to control. There was an increase in flavour of walnut treated *Rista* as compared to the control. The results are in contrast with Serrano *et al.* (2005) who reported the detection of slight off flavour (walnut-like) in the restructured beef steak with walnuts, which was more noticeable in the product that had a higher percentage of added walnut.

## Gravy

The pH, protein, fat, and ash values in the gravies of *Rista* increased with the addition of WKP whereas, the moisture values decreased with the addition of WKP. The increase of pH, protein, fat, and ash content might be due to lesser binding properties of walnuts leading to higher leakage into respective gravies.

Appearance, mouth coating, and saltiness decreased in *Rista* gravy as compared to control. There was an

**Table 3:** Effect of walnut kernels (WK) as a source of antioxidant on the physicochemical quality, compositional quality and antioxidant properties of *Rista* (Mean ± S.E.)

| Parameters (on % basis except pH) | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Emulsion stability | 89.43 ± 0.35$^{c}$ | 88.00±0.58$^{bc}$ | 87.10 ± 0.64$^{b}$ | 85.07 ± 0.58$^{a}$ |
| Cooking yield | 91.50 ± 1.02 | 90.18 ±1.68 | 89.23 ±0.43 | 88.13 ± 0.43 |
| pH | 6.19 ± 0.02$^{a}$ | 6.21 ± 0.005$^{a}$ | 6.28 ± 0.004$^{b}$ | 6.34 ± 0.01$^{c}$ |
| Moisture | 68.38 ± 0.71$^{b}$ | 67.74 ± 0.22$^{b}$ | 67.16±0.46$^{ab}$ | 66.30 ± 0.26$^{a}$ |
| Protein | 16.73 ± 0.29$^{c}$ | 15.93 ± 0.15$^{b}$ | 15.15 ± 0.30$^{a}$ | 14.53 ± 0.19$^{a}$ |
| Fat | 8.49 ± 0.45$^{a}$ | 10.52 ± 0.91$^{b}$ | 10.89 ± 0.58$^{b}$ | 11.28 ± 0.68$^{b}$ |
| Ash | 2.07 ± 0.09 | 2.16 ± 0.02 | 2.20 ±0.21 | 2.32 ± 0.07 |
| DPPH-RSA | 22.07 ± 1.07$^{a}$ | 46.35 ± 1.82$^{b}$ | 56.03 ± 2.06$^{c}$ | 67.07 ± 0.27$^{d}$ |
| ABTS-RSA | 20.05 ± 0.54$^{a}$ | 48.21 ± 1.67$^{b}$ | 54.79 ± 1.74$^{c}$ | 66.74 ± 0.24$^{d}$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 6 except for cooking yield and emulsion stability in which N = 3

**Table 4:** Effect of walnut kernels (WK) on texture profile of *Rista* (Mean ± S.E.)

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Hardness (N) | 22.34±0.004$^{a}$ | 21.44 ±0.004$^{b}$ | 20.24 ±0.004$^{c}$ | 19.51±0.004$^{d}$ |
| Cohesiveness | 0.32 ±0.023 | 0.35±0.025 | 0.37±0.025 | 0.39±0.027 |
| Springiness (mm) | 8.89 ±0.002$^{a}$ | 8.91 ± 0.002$^{b}$ | 8.93 ± 0.002$^{c}$ | 8.94 ± 0.002$^{d}$ |
| Gumminess (N) | 8.65 ±0.003$^{d}$ | 7.44 ±0.004$^{c}$ | 6.34 ±0.003$^{b}$ | 6.12±0.004$^{a}$ |
| Chewiness (J) | 50.44±0.004$^{d}$ | 49.65±0.004$^{c}$ | 48.34 ±0.003$^{b}$ | 47.66±0.003$^{a}$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 6

**Table 5:** Effect of walnut kernels (WK) on colour of *Rista* (Mean ± S.E.)

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Lightness (L) | 36.12±0.002$^d$ | 35.12±0.003$^c$ | 34.12±0.002$^b$ | 33.12±0.003$^a$ |
| Redness (a) | 7.62±0.003$^d$ | 7.52±0.003$^c$ | 7.41±0.002$^b$ | 7.31±0.002$^a$ |
| Yellowness (b) | 11.72±0.002$^d$ | 11.62±0.002$^c$ | 11.52±0.004$^b$ | 11.42±0.003$^a$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 6

**Table 6:** Effect of walnut kernels (WK) as a source of antioxidant on the sensory quality of *Rista* (Mean ± S.E.)

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Appearance | 7.55 ± 0.14$^c$ | 7.51 ± 0.11$^{bc}$ | 7.46 ± 0.12$^b$ | 6.67 ± 0.18$^a$ |
| Flavour | 7.44 ± 0.12$^a$ | 7.57 ± 0.13$^b$ | 7.59 ± 0.19$^b$ | 7.62 ± 0.16$^b$ |
| Juiciness | 7.43 ± 0.13$^b$ | 7.42 ± 0.11$^b$ | 7.39 ± 0.18$^b$ | 7.12 ± 0.22$^a$ |
| Texture | 7.57 ± 0.14$^c$ | 7.48 ± 0.08$^b$ | 7.46 ± 0.16$^b$ | 7.39 ± 0.11$^a$ |
| Mouth coating | 7.50 ± 0.15$^b$ | 7.48 ± 0.13$^b$ | 7.46 ± 0.10$^b$ | 6.93 ± 0.19$^a$ |
| Binding | 7.42 ± 0.10$^c$ | 7.39 ± 0.20$^{bc}$ | 7.33 ± 0.20$^b$ | 7.11 ± 0.10$^a$ |
| Saltiness | 7.17 ± 0.11 | 7.14 ± 0.25 | 7.12 ± 0.13 | 7.08 ± 0.25 |
| Overall acceptability | 7.61 ± 0.11$^c$ | 7.47 ± 0.18$^b$ | 7.44 ± 0.11$^b$ | 6.93 ± 0.21$^a$ |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 15

**Table 7:** Effect of walnut kernels (WK) on the physicochemical quality of *Rista gravy* (Mean ± S.E.)

| Parameters (on % basis except pH) | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| pH | 6.05±0.022$^a$ | 6.07±0.021$^a$ | 6.08±0.017$^a$ | 6.18±0.017$^b$ |
| Moisture | 80.08±0.025 | 80.08±0.027 | 80.06±0.028 | 79.83±0.065 |
| Protein | 2.45±0.015 | 2.45±0.006 | 2.46±0.012 | 2.46±0.012 |
| Fat | 11.12±0.003 | 11.13±0.005 | 11.13±0.005 | 11.14±0.005 |
| Ash | 2.35±0.011 | 2.35±0.013 | 2.36±0.014 | 2.36±0.014 |

Mean ± S.E with different superscripts differ significantly (P<0.05).
N = 6

**Table 8:** Effect of walnut kernels (WK) on the sensory quality of *Rista* gravy (Mean ± S.E.)

| Parameters | Treatments | | | |
|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| Appearance | 7.67±0.126$^b$ | 7.13±0.192$^a$ | 7.13±0.192$^a$ | 7.07±0.182$^a$ |
| Flavour | 6.80±0.262 | 7.13 ± 0.236 | 7.27 ± 0.267 | 7.28± 0.269 |
| Consistency | 6.73 ± 0.182$^a$ | 6.93 ± 0.118$^{ab}$ | 7.20 ± .145$^b$ | 7.33 ±0.126$^b$ |
| Mouth coating | 7.27± 0.118$^c$ | 6.47 ± 0.133$^b$ | 6.20 ± 0.223$^b$ | 5.13 ±0.192$^a$ |
| Saltiness | 7.40 ± 0.131$^c$ | 6.80 ± 0.107$^b$ | 6.73 ± 0.153$^b$ | 6.20 ±0.262$^a$ |
| OA | 7.00 ± 0.258 | 7.07± 0.182 | 7.27± 0.206 | 7.26 ±0.262 |

Mean± S.E with different superscripts differ significantly (P<0.05).
N = 15

increase in flavour, consistency and overall acceptability of walnut treated *Rista* gravy as compared to the control. Overall, panelists did not detect any major differences among the products. The results are in agreement with Hussain (2011), who reported no major difference in the sensory attributes of treatments as compared to the control.

## CONCLUSIONS

Functional *Rista* can be efficiently prepared by decreasing the fat content and addition of walnut kernel paste without any adverse effects. Moreover, walnut kernel paste in the *Rista* improved the overall nutritive, sensory, and antioxidative properties of functional *Rista*.

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