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Effect of incorporation of pomegranate peel powder and essential oils on proximate composition and sensory qualities of goat meat balls

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Abstract
The goat meat balls were prepared by incorporation of 3% pomegranate peel powder (PPP) (T_1), 3% PPP with 0.25% clove essential oil (EO) (T_2), 3% PPP with 1% oregano EO (T_3) and 3% PPP with 0.125% clove + 0.50% oregano EO (T_4) and control without treatment. The mean values for fat, fibre and moisture of the treatment groups were significantly ($P< 0.05$) differ from the control group but treatment samples were not differed significantly ($P< 0.05$) from each other. No significant difference was found between the percent mean values of ash and protein content among all treated and control groups. The average values for overall acceptability of T_4 were significantly higher from all treatment and control groups throughout storage period. The overall acceptability score given by the panelists to all the groups was between moderately desirable to slightly desirable throughout the storage periods. Based on the results, the study revealed that the total dietary fibre content of goat meat balls could be improved with the incorporation of 3% PPP and a combination of clove oil (0.125%) and oregano oil (0.50%) with 3% PPP could be incorporated to develop moderately desirable goat meat balls.

Keywords: Pomegranate peel powder, oregano essential oil, clove essential oil, meat balls

Introduction
Meat is a nutritious and healthier diet for non-vegetarian that provides high-quality proteins, minerals and vitamin B complex [1]. Goat meat is accepted universally but culture, traditions, socio-economic conditions influence consumer preference. Goat meat (chevon) is internationally regarded as a lean red meat with favourable nutritional characteristics [2, 3, 4]. Goat meat is ideal for health-conscious consumers [3, 5] and has an advantageous fatty acid profile with a minimal cholesterol intake risk. Pomegranate (*Punica granatum*) from the Punicaceae family is an important commercial fruit crop that is cultivated recently in western parts of Rajasthan likewise Barmer, Jodhpur, Jalore, Bikaner and Ganganagar districts. Rajasthan stands on 8th rank in pomegranate production [6]. Pomegranate peel is a nutrient-rich inedible by-product obtained during the processing of pomegranate juice [7]. The pomegranate peel powder used as dietary fiber in meat products with minimum changes in texture and by increasing the water binding capacity and provides an economic advantage to the consumer and the producer [8]. Several researchers used pomegranate to reduce lipid oxidation, improved organoleptic properties in fresh and processed meat products. Various studies reported that the incorporation of the essential oils in comminuted meat products improved quality and health benefits [9]. Additionally, in the food matrix as emulsions, nano-emulsions, and coating are some of their new applications [10]. Meat balls are emulsion type products and are also known as meat kofta in India. These meat balls are used as street food at fast food outlets. Meatball is one of the highly consumed meat products and has a short shelf life due to some deteriorative changes during the storage period. Therefore, an experiment was conducted to find out the effect of pomegranate peel powder and essential oils on proximate composition and sensory qualities of goat meat balls.

Material and Methods
Lean goat meat was minced in a meat mincer through a 4 mm plate (SANCO, Model: SFP-56). Pre weighed quantity of minced goat meat, salt, nitrite, and STPP were added in bowl chopper to make meat emulsion and chopped for 2-3 minutes with slow addition of ice flakes. Refined vegetable oil was slowly incorporated while chopping till it was fully dispersed in meat batter.

Condiment paste, dry spice mix and refined wheat flour were added and chopping was continued till uniform distribution of all ingredients and desired consistency of emulsion was obtained. Five different kinds of emulsions were prepared. The control was formulated without the addition of pomegranate peel powder and essential oils and other treatments were prepared by addition of pomegranate peel powder (PPP) at the level of 3% (T_1) and 3% PPP with 0.25% clove essential oil (T_2), 3% PPP with 1% oregano essential oil (T_3) and 3% PPP with a combination of essential oils (0.125% clove + 0.50% oregano) oils (T_4). Each meat ball was prepared manually weighing 20 gm of emulsion. The prepared raw meat balls were placed on cooking trays pre-smeared with vegetable oil to avoid sticking and cooked in a preheated hot air oven at 150^0C for 10-20 minutes. The internal temperature of goat meat balls was monitored by a probe thermometer. After attaining an internal temperature of 75 ± 2^0C the goat meat balls were turned upside down for the initial five minutes of cooking followed by re-turning upside down for the final five minutes of cooking. The goat meat balls after cooling to room temperature were packed in LDPE film pouches and stored at 4 ± 1^0C for the further studies. The sample was analyzed at regular intervals of 5 days upto 15 days of storage (0, 5, 10 and 15 days) for sensory qualities of goat meat balls. Proximate analysis was determined on zero days only. The sensory qualities of samples were evaluated using 9-point hedonic scale [11] where 9 denoted very desirable and 1 denoted very undesirable. Proximate analysis was determined as per procedures of the association of official analytical chemists [12].

Results and Discussion

The mean values of the appearance of treatment groups were significantly (P<0.05) decreased with the advancement of the storage period but no significant decrease in mean values of control group was found. It might be due to oxidative rancidity as indicated by increase TBA and microbial counts with an increase in the period of storage. Appearance scores in decreasing trend during storage period might be due to pigment and lipid oxidation [13]. The analysis of variance showed that mean values of the flavour of treated groups were significantly (P< 0.05) decreased and flavour score of the control group were non-significantly decreased with the increasing storage period. A progressive decrease in flavour scores might be due to an increase in TBA values in meat products [14, 15]. Reported that the flavour score significantly (P< 0.05) decreased on the incorporation of clove oil in chicken sausage samples compared to control. Mean values of juiciness score for T_4 decreased non-significantly upto the 10^{th} day of storage but a significant (P<0.05) decrease was found on 15^{th} day. Decrease in juiciness scores might be due to the use of low-density polyethylene packaging material which has a poor moisture barrier that might have caused the loss of moisture from the products throughout storage period [13, 16]. The tenderness score of all groups significantly (P<0.05) decreased during the storage period of 15^{th} day [17]. also observed that mean values of tenderness significantly (P<0.05) increased on incorporation of pomegranate peel powder in beef sausage samples compared to control and decreased with the advancement of storage period. The overall acceptability score given by the panelists to all treatment and control groups was between moderately desirable to slightly desirable throughout storage periods [18]. reported that mean values of overall acceptability of control and treated products with Pomegranate rind powder in carabeef meat nuggets decreased with the increase in storage period. Overall acceptability of oregano treated chicken patties was also found decreasing with increasing storage period by [13]. The average moisture percentage for treatment groups significantly (P< 0.05) differ from the control but all treated samples did not significantly (P< 0.05) differed among themselves. A similar significant (P< 0.05) decrease in moisture percentage was also reported by [17] in beef sausage on incorporation of pomegranate peel powder. The mean fat values of the products reported that the treatment groups were significantly (P<0.05) higher than control group [19]. Reported that the addition of pomegranate peel powder significantly (P< 0.05) increased fat percentage in beef burgers & might be due to 1.2% fat in pomegranate peel powder [20]. The average fibre percentage for all treated samples significantly higher than the control group but all treated samples were not differed significantly (P< 0.05) among themselves. Higher fibre percentage (19%) in pomegranate peel powder has been reported by [20]. Analysis of variance showed non-significant difference in protein content of all groups [17]. observed that addition of pomegranate peel powder had no significant effect on the protein content of prepared beef sausage. Non-significant (P>0.05) difference was found between the mean values of ash % among all treated and control groups [13]. Reported that mean values of ash content non-significantly differ from control on incorporation of oregano oil in chicken patties. Based on observations of the above study, it can be concluded that the total dietary fibre content of goat meat balls could be improved with the incorporation of 3% pomegranate peel powder. The combination of essential oils (0.125% clove + 0.50% oregano) and 3% pomegranate peel powder could be incorporated to develop goat meat balls with higher overall acceptability.

Table 1: Effect of incorporation of pomegranate peel powder and essential oils on appearance score (mean±se) of goat meat balls under refrigeration temperature (4 ± 1^0 c)

Treatments / Days	Control	T_1	T_2	T_3	T_4
0^{th}	7.250 ± 0.1258^{Ba}	7.400 ± 0.1414^{Ba}	7.325 ± 0.0946^{Ba}	7.175 ± 0.0629^{Ba}	8.000 ± 0.0816^{Aa}
5^{th}	6.950 ± 0.2500^{Ba}	7.300 ± 0.1291^{Ba}	7.175 ± 0.1031^{Bab}	6.925 ± 0.1031^{Bb}	7.875 ± 0.1109^{Ab}
10^{th}	6.750 ± 0.1893^{BCa}	7.075 ± 0.0946^{Bb}	7.050 ± 0.0957^{Bb}	6.700 ± 0.0408^{Cc}	7.625 ± 0.0629^{Ac}
15^{th}	6.400 ± 0.1826^{Ba}	6.925 ± 0.1109^{Ac}	6.875 ± 0.1250^{Ac}	6.375 ± 0.0629^{Bd}	7.250 ± 0.0500^{Ad}

Mean in row bearing a common superscript (capital letters) do not differ significantly (P< 0.05).
Mean in column bearing a common superscript (small letter) do not differ significantly (P< 0.05).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

Table 2: Effect of incorporation of pomegranate peel powder and essential oils on flavour score (mean±se) of goat meat balls under refrigeration temperature (4±1 ^{0}c)

Treatment / Days	Control	T_1	T_2	T_3	T_4
0^{th}	7.275 ± 0.1493^{Ba}	7.400 ± 0.0816^{Ba}	7.150 ± 0.1041^{BCa}	6.950 ± 0.0957^{Ca}	7.900 ± 0.1000^{Aa}
5^{th}	7.250 ± 0.1258^{Ba}	7.200 ± 0.0816^{Bab}	6.800 ± 0.0816^{Cb}	6.800 ± 0.0408^{Ca}	7.800 ± 0.0816^{Aa}
10^{th}	7.200 ± 0.2449^{Aa}	7.000 ± 0.0000^{ABbc}	6.700 ± 0.0577^{BCbc}	6.500 ± 0.0577^{Cb}	7.300 ± 0.0577^{Ab}
15^{th}	7.000 ± 0.2708^{Aa}	6.900 ± 0.0577^{ABc}	6.475 ± 0.0750^{BCc}	6.350 ± 0.1258^{Cb}	7.075 ± 0.0479^{Ac}

Mean in row bearing a common superscript (capital letters) do not differ significantly (P< 0.05).
Mean in column bearing a common superscript (small letter) do not differ significantly (P< 0.05).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

Table 3: Effect of incorporation of pomegranate peel powder and essential oils on juiciness score (mean±se) of goat meat balls under refrigeration temperature (4±1^0 c)

Treatments / Days	Control	T_1	T_2	T_3	T_4
0^{th}	7.225 ± 0.2323^{BCa}	7.550 ± 0.0957^{ABa}	7.050 ± 0.0866^{CDa}	6.875 ± 0.0479^{Da}	7.825 ± 0.0250^{Aa}
5^{th}	7.175 ± 0.1031^{BCa}	7.425 ± 0.0854^{ABa}	6.900 ± 0.1000^{CDab}	6.750 ± 0.0957^{Dab}	7.725 ± 0.1109^{Aa}
10^{th}	6.850 ± 0.1258^{BCb}	7.150 ± 0.0957^{Bb}	6.700 ± 0.1291^{Cbc}	6.625 ± 0.0854^{Cbc}	7.575 ± 0.1436^{Aa}
15^{th}	6.550 ± 0.2062^{Bc}	6.975 ± 0.0629^{Ac}	6.550 ± 0.1708^{Bc}	6.500 ± 0.0577^{Bc}	7.250 ± 0.1258^{Ab}

Mean in row bearing a common superscript (capital letters) do not differ significantly (P< 0.05).
Mean in column bearing a common superscript (small letter) do not differ significantly (P< 0.05).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

Table 4: Effect of incorporation of pomegranate peel powder and essential oils on tenderness score (mean±se) of goat meat balls under refrigeration temperature (4±1^0 c)

Treatments / Days	Control	T_1	T_2	T_3	T_4
0^{th}	7.250 ± 0.1848^{Ba}	7.650 ± 0.0957^{Aa}	7.225 ± 0.0854^{Ba}	7.000 ± 0.0816^{Ba}	7.950 ± 0.0500^{Aa}
5^{th}	7.150 ± 0.0957^{Cab}	7.450 ± 0.0957^{Bb}	6.850 ± 0.0957^{Db}	6.800 ± 0.0816^{Db}	7.900 ± 0.1291^{Aa}
10^{th}	6.850 ± 0.0957^{Cbc}	7.275 ± 0.0750^{Bc}	6.600 ± 0.0816^{Dc}	6.600 ± 0.0816^{Dc}	7.525 ± 0.0479^{Ab}
15^{th}	6.550 ± 0.1893^{Bc}	7.075 ± 0.0479^{Ad}	6.500 ± 0.1000^{Bc}	6.300 ± 0.0577^{Bd}	7.275 ± 0.0750^{Ac}

Mean in row bearing a common superscript (capital letters) do not differ significantly (P< 0.05).
Mean in column bearing a common superscript (small letter) do not differ significantly (P< 0.05).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

Table 5: Effect of incorporation of pomegranate peel powder and essential oils on overall acceptability score (mean±se) of goat meat balls under refrigeration temperature (4±1^0 c)

Treatments / Days	Control	T_1	T_2	T_3	T_4
0^{th}	7.400 ± 0.1225^{Bca}	7.600 ± 0.0816^{Ba}	7.175 ± 0.0854^{CDa}	7.025 ± 0.0629^{Da}	7.975 ± 0.1031^{Aa}
5^{th}	7.100 ± 0.0577^{Cab}	7.350 ± 0.0289^{Bb}	6.950 ± 0.0645^{CDb}	6.800 ± 0.0408^{Db}	7.750 ± 0.0957^{Aab}
10^{th}	6.850 ± 0.0645^{Cbc}	7.175 ± 0.0479^{Bbc}	6.825 ± 0.0946^{Cbc}	6.675 ± 0.0479^{Cbc}	7.525 ± 0.0946^{Abc}
15^{th}	6.650 ± 0.2217^{Cc}	7.050 ± 0.0645^{Bc}	6.650 ± 0.0289^{Cc}	6.550 ± 0.0645^{Cc}	7.425 ± 0.1031^{Ac}

Mean in row bearing a common superscript (capital letters) do not differ significantly (P< 0.05).
Mean in column bearing a common superscript (small letter) do not differ significantly (P< 0.05).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

Table 6: Effect of incorporation of pomegranate peel powder and essential oils on proximate composition (mean±se) of goat meat balls.

Parameters / Treatments	Moisture (%)	Fat (%)	Fibre (%)	Protein (%)	Ash (%)
Control	57.078±0.2873^{A}	12.935±0.1632^{B}	0.930±0.0147^{B}	17.703±0.2901	3.338±0.0180
T_1	55.363±0.2415^{B}	12.980±0.1683^{A}	1.395±0.0377^{A}	18.080±0.3657	3.375±0.0155
T_2	55.553±0.1909^{B}	12.993±0.1667^{A}	1.408±0.0421^{A}	17.875±0.4323	3.358±0.0206
T_3	55.275±0.2496^{B}	12.985±0.1576^{A}	1.388±0.0382^{A}	17.783±0.3409	3.355±0.0236
T_4	55.400±0.4903^{B}	12.990±0.1655^{A}	1.385±0.0366^{A}	17.858±0.3542	3.360±0.0311

Mean in column bearing a common superscript (capital letters) do not differ significantly ($P< 0.05$).
n = 4 for each treatment
Control: Without pomegranate peel powder and essential oils
T_1: 3% Pomegranate peel powder
T_2: 3% Pomegranate peel powder and 0.25% Clove oil
T_3: 3% Pomegranate peel powder and 1% Oregano oil
T_4: 3% Pomegranate peel powder and 0.125% Clove oiI+0.50% Oregano oil

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