1. INTRODUCTION

The progress made by Indian poultry industry is remarkable as it achieved an annual growth of 10.34%. It contributes approximately Rs.47000 crores and support the livelihood of more than 2 million people (USDA, 2012). Indian poultry industry divided into commercial poultry farming and rural back yard poultry farming. Indian rural poultry production contributes about 110 millions birds (Khan, 2008). In rural industry production without investment is the most potent attribute of dual purpose breeds which grow in backyard since centuries in rural area. This dual type coloured birds having better growth performance than indigenous birds.

There are evidence that garlic (*Allium sativum*) has cholesterol lowering effect in humans and animals due to the presence of sulphur-containing bioactive compounds in its homogenates (Chowdhury *et al.* 2002). Garlic clove has well over 33 sulphur compounds, several enzymes, 17 amino acids and minerals especially selenium (Jennifer, 2002). Selenium in garlic accounts for its antioxidant and cancer preventive effects (Ross, 1999).

Omyimonyi *et al.* (2012) concluded that incorporation of sun dried garlic powder @ 750gm /100kg in the diet of broiler result in better performance, reduced serum cholesterol and maintains the hematological and serum chemistry integrity of the broilers. Garlic (*Allium sativum*) is widely used as either a flavoring agent for food or as a medicinal agent for the treatment of a variety of diseases (Sallam *et al.* 2004). Konjufca *et al.* (1997) reported that feeding 3% garlic powder resulted in a decrease of plasma cholesterol and breast and thigh muscle cholesterol in broilers. There were no significant difference in broiler performance in 0, 1, 3 and 5% garlic powder and 3% garlic powder +200 IU of α-tocopherol /kg. Their result suggested that 5% garlic powder or 3% garlic powder +200 IU α-tocopherol antioxidant properties were effective for enhancing lipids and colour stability.

Poultry housing requires protecting birds from the extreme environmental condition in different seasons, from predators and providing optimum opportunities to enable the birds to produce meat and eggs.
efficiently. In India for commercial egg layers or broilers production mostly they either are kept in open type conventional houses or high rise housing system. Rural poultry production is mainly on free range including backyard or scavenger system or semi intensive system under deep litter (Akhtar, 2007). For better supervision of chicks in small area rearing of chicks in battery cages will be advantageous.

Studies on performance of commercial coloured dual purpose chicks having 25% indigenous (Kadaknath) and 75% (Jabalpur coloured) with respect to effect of housing system, energy levels and their interactions are lacking in the literature. On account of scanty information available for optimum growth performance during starter (0 – 8 weeks) age, present study is under taken with following objectives.

**Objectives**

1. To study the effect of dietary energy levels and garlic on growth performance, conformation and carcass trait of commercial dual type coloured chicks.

2. To assess the effect of different housing systems and its interaction effect with dietary treatment on the performance of dual type coloured chicks.

3. To estimate economics of different diet for rearing of chicks under different housing system.
2. REVIEW OF LITERATURE

Housing effect

Johari et al. (1984) carried out an experiment on six strains of White leghorn cross pullets in individual cages and on deep litter system. They reported that body weight in deep litter was higher as compare to cage bird.

Rajini et al. (1996) concluded a 2×2×2 factorial experiment involving two system of rearing viz. cage vs. deep litter, two form of feed mesh vs. pellet and without vs. with oil supplementation. They concluded that cage reared birds showed improve broiler farm economics index than those on deep litter. Higher income over feed cost was recorded in cage reared birds. The feed cost / kg live weight (Rs) worked out to be high in floor reared birds Rs 16.07 and Rs 18.74 for the 6th and 8th weeks of age respectively.

Giri (2004) concluded that two housing system (deep litter and cages) executed significant influence for weekly body weight for both genetic stock. Interaction effects indicated more importance for body weights.

Akthar (2007) reported that body weight of hen kept in cage (H1) was highly significant (P<0.01) than the deep litter hens in the first day of 36 and 40 weeks of age. Body weight of hens kept in cages were significantly (P<0.05) superior than deep litter hens in the 44 weeks of age. Body weight of hens kept in cages and in deep litter were non significant in 1st day of 32 and 44 week. But cage birds were 17.32 g more heavy than deep litter at the end of experiment.

Mikulski et al. (2011) determined the effect of genotype (slower-growing vs. fast-growing) and production system (access to outdoors vs. indoor) on the growth performance of chickens. The experiment was performed on 1,040 day-old hybrid male chickens of two genotypes. Slower-growing chickens (Hubbard JA957, certified) and fast-growing chickens (Hubbard F15) were fed identical diets until 65 days of age. Both genotypes (each represented by 520 birds) were divided into two subgroups and were raised in pens on litter with outdoor access or in indoor confinement without
outdoor access (four replications per subgroup, each of 65 birds). Until day 21, the birds stayed in the indoor facility, in deep-litter pens. The birds could forage on pasture 12 h daily, commencing at three weeks of age. Stocking density was 0.13 m$^2$ floor space per bird in pens on litter, and 0.8 m$^2$ per bird in grassy yards. Compared with fast-growing, slower-growing chickens were significantly lighter (by 17%), were characterized by higher survival rates at 65 days. Outdoor access had no negative effects on the growth performance.

**DIETARY ENERGY**

_energy effect_

Summers and Leeson (1984) conducted experiment with iso-nitrogenous diets containing 2700, 2900, 3100 and 3300 ME kcal /kg and reported that dietary energy level exert little effect on weight gain for males whereas female appear to respond increase in weight with energy levels in diet.

Shyamsunder et al. (1988) reported non significant effect on growth up to 3 weeks period at high and medium energy diet, weight gain was similar but better then low energy diet.

Ayorinde (1994) observed that energy level did not influenced body weight up to 4 week of age and between 5 to 6 week period growth rate increased significantly as the level of dietary energy increased.

Ramarao et al. (2005) conducted an experiment to evaluate the effect of varying dietary energy concentration on performance of Vanaraja chicken during juvenile phase of life. 315 straight run day old chick were divided at random 7 groups of 9 replicate each. Chicks in each 7 group were fed one of the diet containing ME ranging from 2200 to 2800 kcal ME /kg diet from day old to 42 days of age. The concentration of other nutrients essential were adjust to maintain concentration with ME at all energy level tested. At 42 days of age the body weight reduce significantly in group fed diet containing ME below 2400 kcal ME/kg diet.

Panda et al. (2007) Studied effect of metabolizable energy and crude protein requirement of female parent lines of Vanaraja chicks during
their juvenile stage and concluded that chicks from female parent lines of Vanaraja needs 2650 kcal ME/kg diet and 20%CP during juvenile stage.

Rajpura et al. (2010) reported significant dietary treatment effect on body weight of chicks. Colour broiler as studied with varying protein (20, 22 and 23% C.P.) and energy (2700 and 2900 kcal ME/kg) i.e. T1 to T6. Diet T7 prepared with low energy and protein (2400 Kcal ME/kg and 16% C.P.). They observed that chicks fed high energy (2900 kcal ME/kg) irrespective of protein levels had highest body weight.

Azizi et al. (2011) reported the effects of dietary energy and protein dilution and time of feed replacement from starter to grower on performance of broilers with a 2×3 factorial arrangement in a completely randomized design with 480 day-old broilers from 1-42 day of age. Experimental treatments were 5% energy and protein diluted diets and starter diet was fed to 7, 14 or 21 days and finisher diet was fed beginning at 35 days. Grower diet was fed for variable times depending upon termination of feeding starter diet and initiation of finisher diet. Dilution of both energy and protein had no (P>0.05) significant effect on chicks performance. The results from this study suggest that dilution of both energy and protein up to 5% from 1-42 days of age and decreasing the time of starter diet had no adverse effect on broiler chickens performance and it may be beneficial economically.

Singh (2013) studied the effect of protein, energy and probiotic supplementation on growth performance traits on crossbred dual purpose coloured chicks (75% Jb. Colour and 25% Kadaknath). The dietary treatment consisting 3 protein levels are (P1) 17% C.P., (P2) 19% C.P., and (P3) 21% C.P. each with two energy level i.e. (E1) 2700 and (E2) 2900 kcal ME/kg and three levels of probiotic. Dietary energy was non significant indicated lower energy need of coloured dual chicks at all age.

Dietary energy

Garlic effect

Horton et al. (1991) reported that broiler chicks (7 d old) were fed 0, 100, 1000, and 10, 000 mg/ kg dried garlic in a starter diet for 35 d.
Garlic increased average daily weight gain (P < 0.05) during the first 21 d on feed. There were no treatment effects on weight gain when the study was terminated after 35 d.

Dey and Samantha (1993) evaluated the effect of feeding garlic (*Allium Sativum*) as growth promoters in broilers. For 42 days, caged broilers were freely given a commercial diet alone, or with 0.25 and 0.5% garlic (*Allium Sativum*), or conventional growth promoters, Auriomycin (0.01%). Final body weight gain was 552.44, 585.89, 636.99 and 650.22gm., respectively.

Gbenga *et al.* (2009) conducted a trial to assess the effect of dietary garlic (*Allium sativum*) supplementation on the performance and meat quality of broiler chickens using a total of 300 day old Shaver Starbo chicks allotted at 10 birds per replicate and 6 replicates per treatment over a period of 7 weeks. The basal starter and finisher diets contained 22.861 and 20.142 % CP, respectively. The control diet was the basal diet without garlic supplementation. Diets 2 and 3 contained supplementary raw garlic powder at 500 and 5,000 mg/kg diet respectively, while diets 4 and 5 contained supplementary boiled garlic powder at 500 and 5,000 mg/kg diet respectively. 4 female birds per replicate were slaughtered at the end of the trial to evaluate carcass. The average weight gain of the birds were not significantly (P > 0.05) influenced by dietary treatments. Broiler chickens fed garlic supplemented diets had marginally higher weight gain than those fed the control diet and was higher at high level of garlic supplementation (39.18 ± 0.94, 40.42 ± 0.45, 42.39 ± 1.57, 39.72 ± 2.97 and 41.42 ± 2.60 g/bird/day for Diets 1, 2, 3, 4 and 5 respectively; P > 0.05). It was concluded that supplementation of chicken diets with garlic marginally improved weight gain and it was better at high level of supplementation (5,000 mg/kg diet).

Javed *et al.* (2009) found that body weight were improved in a 35 day experimental trial, when broilers were supplemented (at rate of 10ml/litre of drinking water) with an aqueous extract of medicinal plants containing garlic.
Rahmatnejad et al. (2009) concluded that garlic given at the rate of 1000 g/ton of feed did not affect body weight gain.

Kumar et al. (2010) found that garlic supplementation diet (250ppm) significantly increased the body weight gain of broiler chickens in a 42 day trial.

Pourali et al. (2010) reported that garlic powder supplemented diet (250ppm) improved body weight, performance index as well as survivability.

Aji et al (2011) reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chicks.

Mansoub (2011) reported that body weight of broilers were improved when they were fed garlic (1g/kg) in basal diet.

Shrivastava (2011) concluded that the body weight of birds increased from day 0 to 56 in both supplementation, maximum increase in body weight was recorded in group T2 (250mg/Kg feed) garlic oil to birds.

Onyimonyi et al. (2012) conducted experiment of 160 day-old Anak broilers were used in an eight-week trial to evaluate the growth when garlic (Allium sativum) fed at varying dietary levels to broilers. The 160 birds were assigned to four dietary treatments containing 0, 0.25, 0.50 and 0.75 percent garlic in treatments 1, 2, 3 and 4, respectively. Each treatment had forty birds which were replicated four times with 60 birds per replicate in a completely randomized design. The birds were fed a 24% CP broiler starter diet for the first four weeks of the trial and 21% CP finisher diets within the 5th to 8th week. Daily feed intake and weekly body measurements data were kept. Feed conversion and feed cost/kg gain values were calculated. Results showed that the effect of feeding varying dietary levels of garlic on average final body weight, average daily gain and feed cost/kg gain were significant (P<0.05). There was a marked significant improvement of these parameters as levels of garlic in the treatments increased. Birds on the 0.75% garlic (Treatment 4) had significantly higher values of average final body weight, average daily gain and feed cost/kg gain. It is concluded that incorporation of
sun dried garlic powder in the diets of broilers results in better performance, reduced serum cholesterol and further maintains haematological and serum chemistry integrity of the bird.

Eid and Iraqi (2014) investigated the effect of garlic powder on performance of broilers. One hundred and sixty Hubbard chicks at one-day-old were chosen randomly and divided into four groups (40 birds in each group). The chicks in the first group were fed on control diet free of garlic, (GP0), but the 2nd, 3rd and 4th groups received diet supplemented with 100 (GP100), 150 (GP150) and 200 (GP200) g garlic powder/tonne, respectively. Results showed that the diets containing feed additives of garlic powder had highly significant effect on broilers' performance (P<0.0001). It improved live body weights (LBW). Chicks which received diet supplemented with 200 g garlic powder /tonne were affected more positively compared to the other groups. Sex effect was significant (P<0.05) for LBW.

Feed consumption and feed efficiency

Housing system effect

Giri (2004) studying two housing system (deep litter and cages) executed significant influence for weekly feed efficiency of both genetic stocks, better feed utilization was measured under deep litter housing system than cage housing system. Interaction effects indicated more importance for feed efficiency.

Energy effect

Ayorinde (1994) reported that feed intake decreased significantly as the level of dietary energy was increased.

Rajini et al. (1998) reported significantly better feed efficiency with high energy diet.

Atkare (2001) studied the performance of coloured dual and meat type chicks feeding in finisher phase with 2800, 3000, 3200 kcal ME/Kg. Effect of energy was significant on feed efficiency in both season. Increasing energy level significantly improved feed efficiency. Protein × energy were non significant.
Ramarao et al. (2005) reported that the FCR during 01-42 days of age varied significantly with energy level and was comparable among the dietary group containing 2600 to 2800 kcal ME/kg diet. Reducing ME content of diet below 2600 kcal ME/kg diet adversely affected the FCR.

Dehury et al. (2008) reported that broiler chicks fed 2900 ME level with 20 and 21% C.P. and 3000 ME level with 20, 21% C.P. were non significantly different.

Dairo et al. (2010) reported significantly (p<0.05) better FCR in normal energy normal protein (23.0: 2970), a trend also exhibited by protein efficiency ratio (PER). The FCR in finisher phase was better for birds on moderate protein and high energy (20.14% C.P. and 2995Kcal ME) but lowest for low energy high protein (22.17% C.P. and 2802 kcal ME/kg).

Rajpura et al. (2010) reported significant better FCR with high energy diet irrespective of protein.

Singh (2013) concluded that feed intake g/bird was lower in E2 high energy diet than E1 low energy diet with significant difference at 2nd, 6th and 8th week of age. Energy level E2 showed significantly better feed efficiency (F.E.) during 2nd, 4th, 6th, and 10th week of age.

Garlic effect

Horton et al. (1991) reported that broiler chicks (7 d old) were fed 0, 100, 1000, and 10,000 mg/ kg dried garlic in a starter diet for 35 d. There were no treatment effects on feed intake or efficiency when the study was terminated after 35 d.

Javandel et al. (2008) observed that feeding garlic at level of 0.125 and 0.25% resulted in higher feed intake during the starter phase of broilers, although the same levels were not efficacious during the growing phase.

Gbenga et al. (2009) reported that average feed intake and feed conversion ratio were not significantly influenced by dietary treatments.
Rahmatnejad et al. (2009) concluded that garlic given at the rate of 1000 g/ton of feed did not affect feed intake and FCR.

Pourali et al. (2010) reported that garlic powder supplemented diet (250ppm) improved average daily feed intake, FCR, performance index as well as survivability.

Rajpura et al. (2010) reported that dietary treatment exerted significant effect on feed consumption and FCR. Chicks fed high energy irrespective of protein level shown higher FCR.

Mansoub (2011) reported that feed conversion ratio of broilers were improved when they were fed garlic (1g/kg) in basal diet.

Eid and Iraqi (2014) investigated the effect of garlic powder on performance of broilers (e.g. cumulative feed intake and feed conversion ratio). One hundred and sixty Hubbard chicks at one-day-old were chosen randomly and divided into four groups (40 birds in each group). The chicks in the first group were fed on control diet free of garlic, (GP0), but the 2nd, 3rd and 4th groups received diet supplemented with 100 (GP100), 150 (GP150) and 200 (GP200) g garlic powder/tonne, respectively. Results showed that the diets containing feed additives of garlic powder had highly significant effect on broilers' performance (P<0.0001). It was improved feed conversation ratio (FCR); decreased Cumulative Feed Intake (CFI). Chicks which received diet supplemented with 200 g garlic powder /tonne were affected more positively compared to the other groups.

**Conformation traits**

Shyamsunder et al. (1988) reported non significant effect of energy levels on breast angle, shank length, and keel length.

Mahadik (1994) reported significant energy level effect on breast angle and non significant for shank length and keel length of broilers.

Atkare (2001) conducted experiment on meat and dual type colour chicks with variable protein and energy levels during hot and cold climate, and observed significant effect of energy level on breast angle and
shank length of pooled sex broiler chicks in both the climate and keel length during cold climate.

Giri (2004) studying two housing system (deep litter and cages) executed non significant effect on conformation traits and are less importance of confirmation traits.

Singh (2013) concluded that energy effect was significant for 8th week and 10th week for keel length.

**Carcass traits**

**Housing effect on carcass traits**

Giri (2004) reported that two housing system (deep litter and cages) executed significant influence for percent total meat yield of both genetic stock. Interaction effects indicated more importance for carcass.

Mikulski *et al.* (2011) determined the effect of genotype (slower-growing vs. fast-growing) and production system (access to outdoors vs. indoor) on the growth performance of chickens. The experiment was performed on 1,040 day-old hybrid male chickens of two genotypes. Slower-growing chickens (Hubbard JA957, certified) and fast-growing chickens (Hubbard F15) were fed identical diets until 65 days of age. Both genotypes (each represented by 520 birds) were divided into two subgroups and were raised in pens on litter with outdoor access or in indoor confinement without outdoor access (four replications per subgroup, each of 65 birds). Until day 21, the birds stayed in the indoor facility, in deep-litter pens. The birds could forage on pasture 12 h daily, commencing at three weeks of age. Stocking density was 0.13 m² floor space per bird in pens on litter, and 0.8 m² per bird in grassy yards. Compared with fast-growing, slower-growing chickens were significantly lighter (by 17%), had a lower breast and thigh muscle yield and a higher abdominal fat content, but they were characterized by higher survival rates at 65 days, a higher protein content and a lower fat content of breast meat.
Energy effect

Shayamsunder et al. (1988) reported significant energy level effect on eviscerated yield, total meat yield and cut-up yield except leg weight.

Raju et al. (1996) reported significantly high carcass yield and weight of abdominal fat with higher energy level (2900 kcal ME/kg) then the lower energy level (2600 and 2750 kcal ME/kg).

Rao et al. (1996) reported that dietary regime had non significant effect on blood loss and ready to cook yield. The abdominal fat pad and giblet yield were least in reference diet (22 % C.P. and 2900 kcal ME/kg) and was higher in severely restricted diet (18 %C.P. and 2700 kcal ME/kg).

Rajini et al. (1998) evaluate carcass yield of commercial broiler feeding three energy level 2500, 2700, 2900 kcal ME/kg in hot and cold climate. Both eviscerated carcass and ready to cook yield was not affected by energy level of diet.

Atkare (2001) reported non significant effect of energy levels on carcass traits in both hot and cold climate except total meat yield of female in hot climate.

Ramarao et al. (2005) reported that the amount of fat deposition in abdominal area was significantly reduced by reducing dietary energy content. The cost of feed required to produce kg weight gain in groups fed 2400 kcal ME /kg diet was significantly less compared to those fed high ME diet greater than 2600 kcal ME / kg diet. Considering the weight gain and cost of production, it can be concluded that Vanaraja chicks need 2400 kcal ME /kg diet for optimum performance during 1-42 days of age.

Azizi et al. (2011) concluded that dilution of both energy and protein had significantly increased breast meat yield.

Singh (2013) concluded that energy effect was non significant for eviscerated yield, percent giblet was significant by energy levels in female and total meat yield percent in male.
Garlic powder effect

Ashayerizadeh et al. (2009) demonstrated that garlic added into the broiler feed had a significant effect on carcass yield, but thigh and breast weight did not change, although abdominal fat % decreased in garlic supplemented birds.

Gbenga et al. (2009) conducted to assess the effect of dietary garlic (*Allium sativum*) supplementation on the performance and meat quality of broiler chickens. The carcass and organ characteristics of the chickens were not significantly affected (P>0.05) by dietary garlic supplementation but abdominal fat contents were numerically lowered due to supplementary garlic. It was concluded that supplementation of chicken diets with garlic marginally improved meat quality by increasing meat palatability score and reducing the extent of oxidation of meat during refrigerated storage.

Mahmood et al. (2009) concluded that a basal feed containing 0.5% garlic failed to produce positive effects on carcass yield in term of dressing percentage, relative weight of heart, gizzard, liver, spleen and pancreas.

Economic

Rajini et al. (1996) concluded a 2×2×2 factorial experiment involving two system of rearing viz. cage vs. deep litter, two form of feed mesh vs. pellet and without vs. with oil supplementation. They concluded that cage reared birds showed improve broiler farm economics index than those on deep litter. Higher income over feed cost was recorded in cage reared birds. The feed cost / kg live weight (Rs) worked out to be high in floor reared birds Rs 16.07 and Rs 18.74 for the 6th and 8th weeks of age respectively.

Ramarao et al. (2005) concluded that the cost of feed required to produce kg weight gain in groups fed 2400 kcal ME /kg diet was significantly less compared to those fed high ME diet greater than 2600 kcal ME / kg diet. Considering the weight gain and cost of production, it can be concluded that Vanaraja chicks need 2400 kcal ME /kg diet for optimum performance during 1-42 days of age.

Singh (2013) concluded that significantly higher income over feed cost in E₁ energy was rupees 34.55. The lowest profit found in high protein-high energy diet with or without probiotic.
3. MATERIALS AND METHODS

Location and Place of Work

The experiment was conducted in the Department of Poultry Science, College of Veterinary Science and Animal Husbandry, N.D.V.S.U, Jabalpur (M.P.). The required facilities for experiment were available under All India Co-ordinated Research Project on Poultry Breeding.

Experimental Population and Mating Design

The experiment population involved in the present experiment was commercial dual type coloured chicks. The experimental population was produced by crossing crossbred Kadaknath males (Kadaknath 50%: purebred Jabalpur colour 50%).

Mating Design

Crossbred Kadaknath male x Jabalpur Colour Female
(Kd 50%: Jb Col. 50%) (Jb colour 100%)

Dual Colour Bird
(Kd 25%: 75% JB Col)

Artificial Insemination

Healthy sire line crossbred Kadaknath (50% Kd: 50% Jb Colour line) males were selected and housed in individual cages before a month expected to yield semen artificially. All the male were trained for producing quality semen artificially prior to their use of A.I. Simultaneously randomly selected normal bodies colour dual chicks producing dam line 100 female (Jb. Colour line) were housed in individual breeder cages.

The female were artificially inseminated with collected semen from males on first day, repeated on third day and thereafter every fifth day.
Collection & Incubation of Eggs

After 24 hours of second insemination fertile eggs were collected over a period of 7 days and were stored for incubation on the basis of shell condition, shape, egg weight and egg size. The selected egg were sanitized by swabbing with spirit and then with formaldehyde fumigation of 3x concentration for 20 minutes prior to storage at 60°F and 75% R.H.

Before incubation, eggs were fumigated again with formaldehyde with 2x concentration for 20 minutes. The selected eggs were arranged in incubator after its cleaning and disinfection. The eggs were candled after 18th day of incubation and those eggs having developing embryo were transferred to hatcher machine. On day 22nd chicks were removed from hatcher machine. Required number of healthy chicks were randomly picked up and wing banded to maintain individual identity and weighed.

Rearing of Chicks

A fortnight before starting of experiment, the experimental shed with pan housing facility was properly cleaned and white washed. Saw dust was used as bedding material with initial thickness of 5–7cm. 200 watts bulbs for brooding were provided in each pan to control and maintain desired temperature.

Managemental

Daily weighed amount of ration was offered in each pan as per treatment group. Waterers were washed daily and clean drinking water was provided. All monumental factors were kept identical for all treatment groups except for dietary treatment. The chicks were reared up to 8 weeks of age for collection of data.

Medication & Vaccination

During first 5 days chicks were given lixen power of 5gm/300 chicks and vitamin B complex at 7ml/100 chicks through drinking water. Coccidiostat (Dicalzuri 1kg/ton) was added in feed from third week of experiment. All the chicks were vaccinated against Marek's disease at day old age through S/C route in dorsal cervical region. Ranikhet disease vaccine
B<sub>1</sub>/F<sub>1</sub> was given at 5<sup>th</sup> day through eye drop method. IBD intermediate at 14<sup>th</sup> day through drinking water and repeated at 28<sup>th</sup> day through drinking water method with Skimmed milk powder. The booster RD Losota vaccine was given at 21<sup>st</sup> day through drinking water method with skimmed milk powder.

**Experimental design & distribution of chicks**

Two way analysis of variance with interaction design (Completely Randomized design) was utilized in present study having 3 energy level with Isonitrogenous diet and supplementation of garlic powder. The experimental population consists of 160 day old commercial dual coloured chicks. The chicks were distributed equally to two housing systems. H<sub>1</sub> were reared in battery brooder and H<sub>2</sub> group in deep litter pens as per replicate wise and treatment wise. Each treatment was consisting of 2 replicates containing 10 chicks in each unit. The distribution of chicks (day old to 8 weeks age) in different dietary treatment groups are shown in table no.1.

**Table 01: Distribution of chicks to different dietary treatments**

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Dietary treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>Battery Brooder (H&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>R&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Deep litter (H&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>R&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Per Housing System</td>
<td>80</td>
</tr>
<tr>
<td>Per Dietary System</td>
<td>40</td>
</tr>
<tr>
<td>Total no. of chicks</td>
<td>160</td>
</tr>
</tbody>
</table>

D<sub>1</sub> = 2500 ME kcal/kg and 22% CP  
D<sub>2</sub> = 2700 ME kcal/kg and 22% CP  
D<sub>3</sub> = 2900 ME kcal/kg and 22% CP  
D<sub>4</sub> = 2700 ME kcal/kg and 22%CP +750g dried garlic powder/100kg diet.

**Dietary Treatment**

The four dietary treatment containing 3 different energy levels with Isonitrogenous diet, and supplementation of garlic powder, ie. D<sub>1</sub> 2500,
D_2 2700, D_3 2900 and D_4 2700 kcal ME + Garlic power. The 22% CP levels in the each diet kept constant.

Experimental chicks were hatched on 13/02/13 and experiment was conducted wef. 14/02/13 to 11/04/13. Feed was prepared at project feed godown keeping all precaution to minimize error. Feed ingredient were visually inspected for quality, grinded, weighed and mixed utilizing grinder and mixer machines.

Minerals, Vitamins and additive were mixed by preparing premix then added to bulk ration and mixed thoroughly in each experimental diet having 22% CP with different energy level 2500, 2700, 2900 and 2700 + garlic powder kcal ME/100 kg diets.

Table 02: Chemical composition of diet

<table>
<thead>
<tr>
<th>Ingredients kg/100 kg</th>
<th>D_1 2500 kcal ME/kg</th>
<th>D_2 2700 kcal ME/kg</th>
<th>D_3 2900 kcal ME/kg</th>
<th>D_4 2700 kcal + 750g dried garlic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>34.5</td>
<td>33</td>
<td>60</td>
<td>33</td>
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<tr>
<td>Rice polish</td>
<td>-</td>
<td>29.10</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>Rice kanki</td>
<td>24.10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Soyabean meal</td>
<td>32.5</td>
<td>32.5</td>
<td>24.4</td>
<td>31.6</td>
</tr>
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<td>Fish meal</td>
<td>-</td>
<td>1.5</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>Meat meal</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oil</td>
<td>-</td>
<td>-</td>
<td>1.7</td>
<td>-</td>
</tr>
<tr>
<td>Mineral Mix.</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin Mix.</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>DCP</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Cocidiostat</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Salt</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Added Additionally</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>750g/100 kg</td>
</tr>
</tbody>
</table>

Note: Crude Protein% in all four diets was 22%.

Calculated Composition of diet for CP & Energy

| Protein | 22 | 22 | 22 | 22 |

17
<table>
<thead>
<tr>
<th>Energy kcal ME/kg</th>
<th>2500</th>
<th>2720</th>
<th>2898</th>
<th>2720 + garlic</th>
</tr>
</thead>
</table>

**Mineral Mixture**

Composition (Per 100 kg of diets)
- KI: 20mg
- MgSO₄: 33.6g
- CuSO₄: 2.5g
- FeSO₄: 42.0g
- ZnSO₄: 25.0g
- Salt: 300.0g

**Vitamin Premix**

Composition
- Each 5kg Contains:
  - Vit A: 100,000,000 IU
  - Vit D₃: 20,000,000 IU
  - Vit B₂: 4.0g
  - Vit B₁₂: 12.0g
  - Vit E: 2.0g
  - Vit K: 2.0g
  - Calcium Pantothenate: 5.0g
  - Nicotinamide: 20.0g
  - Chloride Chloride: 300.0g
  - Calcium: 150.0g
  - Managenese: 55.0g
  - Iodine: 2.0g
  - Iron: 15.0g
  - Zinc: 30.0g
  - Copper: 4.0g
  - Cobalt: 0.9g

The experiment was conducted upto 8 week of age keeping similar condition of management throughout the experimental period. Daily measured amount of feed was offered to calculate feed consumption and feed efficiency.

**Data Collection**
Data collected under 4 dietary treatments from day old to 8 weeks of age, involved performance traits such as growth, feed efficiency, conformation, carcass traits and mortality. Body weight was measured by weighing individual chick on weekly basis up to 8 weeks of age. Chicks were fed experimental ration ad-libitum. Difference in initial and final body weight represented weight gain by chicks over the corresponding period. A weighed amount of each diet were provided to replicated chicks group and feed consumed (g) to weight gain (g) on weekly basis was recorded regularly for each group and calculated. Conformation traits like breast angle, shank length and keel length were measured on all the birds at 8th weeks of age.

At 8th weeks of age two males from each treatment group were randomly selected and sacrificed by ethnic slaughtering method to study the carcass performance of dual type coloured birds.

Measurement of traits:-

Experimental chicks were housed at day old to 8 weeks of age for conducting nutrient trial and collection of data. The following traits were measured.

(a) Body Weight

Individual chicks were weighed on replicate wise weekly basis to the nearest 1g in 1 to 3 weeks and thereafter to 10g during 4 to 8 weeks of age.

(b) Feed efficiency as food conversion ratio

This was obtained on replicated group basis. The total feed consumed when divided by the total gain in weight gave the measurement of feed efficiency (on weekly basis).

\[
\text{Food conversion ratio} = \frac{\text{Total Feed Consumed (g)}}{\text{Total weight gain (g)}}
\]

(c) Percent Mortality
It was calculated on the basis of dead chicks during the entire experimental period.

\[
\text{Percent Mortality} = \frac{\text{Total no. of dead birds}}{\text{Total no. of birds}} \times 100
\]

(d) Conformation traits

It was measured at 8 weeks of age on individual chicks.

(i) Keel length

Vernier Calliper was used to measure keel length as a distance between the point of ischium and the point of Keel to the nearest 0.01 centimeters.

(ii) Shank length

Shank length was measured as the distance between hock joint and carpal joint by using vernier calliper to the nearest 0.01 centimeters.

(iii) Breast angle

Breastometer was used to measure breast angle (°) at a point about one and half inches posterior to the anterior edge of the keel bone.

(e) Carcass Characteristics

At the end of experiment 2 males from each treatment group were picked up randomly to study the effect of genotype and different nutrient level on carcass traits. Birds were deprived of feed for overnight and were re-weighed the following day. Birds were slaughtered as per the improved Kosher's method. Bleeding was done for 3 minutes, scalded at 58°C for 90 second. Plucking was done mechanically to determine blood and feather loss. The head and legs were separated from the carcass by cutting at the atlanto-occipital and hock joints respectively. Evisceration was carried out by the removing trachea, oesophagus and viscera. Eviscerated carcasses were cleaned, drained and weighed. Giblets including gizzard,( without mucosa and ingesta), heart without peritonium and liver without gall bladder were cleaned
and weighed. The fat were separated from gizzard, carcass and viscera and weighed as abdominal fat.

Eviscerated carcass along with giblet constituted the total meat yield. Eviscerated carcasses were utilized for the measurement of % carcass cut-up parts like breast, legs, back with neck and wings. The thigh were removed at the junction of ilium, the wings were severed at the junction of humerus and scapula. Back and neck were separated from breast, by cutting along a line parallel to thoracic vertebrae and extending from a caudal tip of the floating ribs, through the junction of vertebral (dorsal segments) and sternal (ventrally segments) ribs.

(i) **Dressing Percentage**

\[
\text{Dressing weight (\%) } = \frac{\text{Eviscerated wt.}}{\text{Starved wt.}} \times 100
\]

(ii) **Giblet wt. (%)**

\[
\text{Giblet weight (\%) } = \frac{\text{Giblet wt.}}{\text{Starved wt.}} \times 100
\]

(iii) **Abdominal Fat Percentage**

\[
\text{Abdominal fat (\%) } = \frac{\text{Abdominal fat wt.}}{\text{Starved wt.}} \times 100
\]

(iv) **Cut up parts (%)**

\[
\text{Cut up parts (\%) } = \frac{\text{Weight of individual cut up parts}}{\text{Dressed wt.}} \times 100
\]
Economics

The income of chicks over feed cost were calculated on the basis of feed consumed for per kg of body weight gain and cumulative feed consumption (day old to 8th weeks) for total weight gain per birds.

Statistical Analysis

The present experiment was conducted in a two way analysis of variance (Completely Randomized Design) consisting of housing effect and 3 energy levels, garlic effect. The data of 160 birds was utilized to study the effect of housing, energy and garlic supplementation and their interaction on growth performance traits and carcass traits.

Mean and standard error (SE), were calculated for all traits as per Steel and Torre (1984), using following formula.

(a) Mean

\[ \bar{X} = \frac{\sum_{i=1}^{n} x_i}{n} \]

Where,

\[ \sum x = \text{Sum of observation of traits on } i^{th} \text{ individual} \]

\[ N = \text{number of observation} \]

\[ \bar{X} = \text{arithmetic mean} \]

(b) Standard error (SE)

\[ \text{SE} = \sqrt{\frac{\text{SD}}{n}} \]
Where,

\[
\begin{align*}
SD & = \text{Standard deviation} \\
n & = \text{number of observation} \\
SE & = \text{Standard error}
\end{align*}
\]

**Standard Deviation (SD)**

\[
\overline{X} = \frac{\sum x_i^2 - (\sum x_i = 1 x_i)^2}{n - 1}
\]

Where,

\[
\begin{align*}
n & = \text{number of observation} \\
\Sigma & = \text{sum of observation of traits on } i^{th} \text{ individual} \\
\Sigma x_i^2 & = \text{sum of square of observation}
\end{align*}
\]

**Statistical Model**

The following model is used to analyze the data to study effect of housing system, dietary energy and dried garlic powder and their interaction effect on the performance of dual purpose commercial coloured birds.

\[
Y_{ijk} = \mu + H_i + D_j + (HD)_{ij} + E_{ijk}
\]

Where,

\[
\begin{align*}
\mu & \quad \text{is the overall mean} \\
H_i & \quad \text{is the effect of } i^{th} \text{ housing system and } i \text{ varies from 1-2} \\
D_j & \quad \text{is the effect of } j^{th} \text{ diet and } j \text{ varies from 1-4} \\
(HD)_{ij} & \quad \text{is the interaction effect of } i^{th} \text{ housing system and } j^{th} \text{ diet.}
\end{align*}
\]
$E_{ijk}$ is the random error normally and is dependently distributed with zero means and variance.

**Group mean test:**

Pair wise comparison of means was estimated by using Duncan's multiple range tests as described by Duncan (1955).
4. RESULTS

The present study was planned to evaluate the effect of housing system, dietary energy and dried garlic powder supplementation with using two way analysis of variance with interaction under completely randomized design for analysis, of data on growth performance, feed intake, FCR, conformation and carcass traits. The commercial coloured dual type chicks (Kadaknath 25%: Jabalpur color 75%) were produced from mating of crossbred Kadaknath male (Kadaknath 50%: Jabalpur colour 50%) with pure bred Jabalpur colour bird as female line.

A total number of 160 healthy chicks were taken and randomly divided into equal 4 dietary treatments, and randomly distributed equally to two housing system. H$_1$ group were reared in battery brooder and H$_2$ group chicks reared in the deep litter pen as per replicate wise and 4 dietary treatment wise. The dietary treatments are 2500 (D$_1$), 2700 (D$_2$), 2900 (D$_3$) kcal/ME/kg and D$_2$+750 g dried garlic powder per quantal of diet (D$_4$). Each treatments group had 20 chicks divided in two replicate equally.

This population is being maintained at All India Cordinated Research Project on poultry breeding, Department of Poultry Science NDVSU, Jabalpur M.P.

The performance traits of birds were evaluated in term of weekly body weight upto eight weeks of age, weekly feed consumption to calculate average feed intake/day at weekly interval and feed efficiency at weekly interval. Data of conformation and carcass traits was measured at 8$^{th}$ week of age by taking 2 males from each treatment group.

Analysis of variance revealed that the difference between the replicates were non significant for the study. As such all the measurement and analysis were done on data pooled over replicate. The growth traits were analyzed on pooled sex basis, whereas carcass traits were analyzed for male sex only.
Weekly body weight means along with their standard error according to housing system, dietary level are presented in table 3 and 4. Mean due to interaction effect is summarized in table 05. Mean sum of squares obtained with analysis of variance is given in table 06. The graphically of body weight by mean and interaction effect are depicted in fig 01 to 03.

**Table 03: Effect of housing on body weights from day old to 8 weeks of age**

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Day old</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery brooder (H₁)</td>
<td>34.49±0.37</td>
<td>136.19±2.17</td>
<td>165.34±2.90</td>
<td>291.22±3.96</td>
<td>368.05±4.77</td>
<td>427.33±7.12</td>
<td>672.87±8.01</td>
<td>754.62±7.98</td>
<td>879.06±9.85</td>
</tr>
<tr>
<td>Deep litter(H₂)</td>
<td>34.49±0.38</td>
<td>126.65±2.11</td>
<td>156.78±2.52</td>
<td>280.73±3.79</td>
<td>357.71±4.18</td>
<td>406.22±5.52</td>
<td>666.56±8.32</td>
<td>737.15±7.26</td>
<td>866.50±8.61</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

**Body weight**

The mean for body weight of dual colour chicks at day old age in each 8 treatments is presented in table 03. Statistically non significant housing and dietary energy and their interaction effect were detected for day old body weight analyzed on pooled sex basis.

**First week body weight**

Statistically highly significant for housing & dietary effect were detected for first week body weight. On the contrary interaction effect were non significant. Chicks kept in battery brooder (H₁) were weighed significantly higher (136±2.17g) than litter (126.65±2.11g). Chicks fed 2900 kcal/ME/kg (D₃) were significantly heavier in body weight than chicks offered 2700 kcal/ME/kg (D₂) and 2500 kcal/ME/kg (D₁) lower energy diet. Body weight in D₂ and D₁ diet was also highly significantly different. The mean body weight in D₁, D₂ and D₃ were 106.55±1.77 g, 126.65±1.66 g and 142.00±1.22 g. The diet having 2700 kcal/ME/kg + garlic powder (D₄) is significantly heavier than 2700 kcal/ME/kg (D₂). The mean body weight D₄ diet 150.48±1.92 g.
Table 04: Effect of energy levels on body weights from day old to 8 weeks of age

<table>
<thead>
<tr>
<th>Levels of energy Kcal ME/Kg</th>
<th>Day old</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>D_1 (2500)</td>
<td>34.47±0.55</td>
<td>106.55±1.77</td>
<td>134.98±1.99</td>
<td>246.83±3.46</td>
<td>330.50±4.71</td>
<td>382.45±7.27</td>
<td>645.75±10.53</td>
<td>720.25±8.64</td>
<td>854.63±9.13</td>
</tr>
<tr>
<td>D_2 (2700)</td>
<td>34.54±0.45</td>
<td>126.65±1.66</td>
<td>151.15±2.04</td>
<td>278.40±3.37</td>
<td>358.48±4.98</td>
<td>415.40±9.06</td>
<td>672.00±10.64</td>
<td>726.88±9.40</td>
<td>859.25±15.04</td>
</tr>
<tr>
<td>D_3 (2900)</td>
<td>34.88±0.56</td>
<td>142.00±1.22</td>
<td>169.90±2.23</td>
<td>301.35±2.80</td>
<td>372.90±6.04</td>
<td>426.85±9.36</td>
<td>678.25±13.40</td>
<td>759.63±9.15</td>
<td>880.13±13.13</td>
</tr>
<tr>
<td>D_4 (2700+ garlic)</td>
<td>34.10±0.54</td>
<td>150.48±1.92</td>
<td>188.20±2.77</td>
<td>317.35±4.64</td>
<td>389.65±5.86</td>
<td>442.43±9.36</td>
<td>682.88±13.07</td>
<td>776.80±13.66</td>
<td>897.13±13.66</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 05: Effect of housing × energy levels Interaction on body weight from day old to 8 weeks of age

<table>
<thead>
<tr>
<th>H×D</th>
<th>Day old</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>H_1D_1</td>
<td>34.14±0.61</td>
<td>112.50±2.44</td>
<td>136.80±3.48</td>
<td>252.65±5.19</td>
<td>335.50±7.80</td>
<td>386.50±10.25</td>
<td>646.50±14.56</td>
<td>735.25±11.18</td>
<td>856.25±13.01</td>
</tr>
<tr>
<td>H_1D_2</td>
<td>34.00±0.92</td>
<td>132.50±2.21</td>
<td>157.00±3.30</td>
<td>284.40±3.30</td>
<td>363.50±8.97</td>
<td>430.50±15.13</td>
<td>676.50±17.47</td>
<td>741.25±14.61</td>
<td>861.25±16.77</td>
</tr>
<tr>
<td>H_1D_3</td>
<td>35.45±0.94</td>
<td>143.75±1.81</td>
<td>177.50±1.95</td>
<td>307.50±4.31</td>
<td>376.90±5.27</td>
<td>440.50±10.49</td>
<td>682.50±15.60</td>
<td>761.50±12.55</td>
<td>896.25±13.15</td>
</tr>
<tr>
<td>H_1D_4</td>
<td>34.40±0.65</td>
<td>156.00±0.94</td>
<td>190.05±1.87</td>
<td>320.35±4.17</td>
<td>396.30±8.23</td>
<td>451.85±10.53</td>
<td>686.00±20.73</td>
<td>780.50±12.55</td>
<td>902.50±19.97</td>
</tr>
<tr>
<td>H_2D_1</td>
<td>34.80±0.60</td>
<td>100.60±2.45</td>
<td>133.15±2.85</td>
<td>241.00±5.25</td>
<td>325.50±7.89</td>
<td>378.40±15.13</td>
<td>645.00±15.05</td>
<td>705.25±14.38</td>
<td>853.00±23.18</td>
</tr>
<tr>
<td>H_2D_2</td>
<td>35.09±0.78</td>
<td>120.80±2.83</td>
<td>145.30±4.72</td>
<td>272.40±7.54</td>
<td>353.45±8.55</td>
<td>400.30±12.39</td>
<td>667.50±16.51</td>
<td>712.50±21.16</td>
<td>857.25±23.22</td>
</tr>
<tr>
<td>H_2D_3</td>
<td>34.30±0.65</td>
<td>140.25±1.29</td>
<td>162.30±2.32</td>
<td>295.20±3.92</td>
<td>368.90±6.08</td>
<td>413.20±9.17</td>
<td>674.00±15.38</td>
<td>757.75±11.60</td>
<td>864.00±19.97</td>
</tr>
<tr>
<td>H_2D_4</td>
<td>33.80±0.77</td>
<td>144.95±1.97</td>
<td>186.35±2.99</td>
<td>314.35±5.52</td>
<td>383.00±7.95</td>
<td>433.00±10.91</td>
<td>679.75±14.38</td>
<td>773.10±15.88</td>
<td>899.75±14.98</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Interaction due to housing system (H) x dietary level (D) was non significant effect for day old to 8th week body weight. The H₁D₄ and H₂D₄ group chicks body weight was heaviest 156.00±0.94 g and 144.95±1.97 g respectively.
Second week body weight

Statistically highly significant for housing and dietary effect were detected for 2\textsuperscript{nd} week body weight on the contrary interaction effect were least important chicks kept in battery brooder were weighed significantly higher 165.34±2.90g than deep litter (156.78±2.52).

Chicks fed D\textsubscript{3} diet were significantly heavier than chicks offered D\textsubscript{2} and D\textsubscript{1} diet. Body weight in D\textsubscript{2} and D\textsubscript{1} energy level were significantly different, the mean body weight in D\textsubscript{1}, D\textsubscript{2} and D\textsubscript{3} were 134.98±1.99 g, 151.15±2.04 g and 169.90±2.23 g. The D\textsubscript{4} diet is significantly heavier than D\textsubscript{2} diet. The mean body weight of D\textsubscript{4} diet is 188.20±2.77 g.

Third week body weight

Statistically highly significant for housing and dietary effect were detected for 3\textsuperscript{rd} week body weight on the contrary interaction effect were not significant chicks kept in battery brooder significantly weighed higher 291.22±3.96 than in deep litter 280.73±3.79. Chicks fed diet D\textsubscript{3} were significantly heavier than those chicks offered D\textsubscript{2} and D\textsubscript{1} diet. Body weight in D\textsubscript{2} and D\textsubscript{1} energy level was also highly significantly different. The mean body weight in D\textsubscript{3}, D\textsubscript{2} and D\textsubscript{1} were 301.35±2.80, 278.40±3.37 and 246.83±3.46 g. The D\textsubscript{4} diet is significantly heavier than 38.95g with D\textsubscript{2} diet. The mean body weight of D\textsubscript{4} diet is 317.35±4.64 g.

Interaction due to HxD treatment was non significant effect for body weight.

Fourth week body weight

Statistically non significant effect for housing system but highly significant for dietary effect were detected for 4\textsuperscript{th} week body weight, on the contrary interaction effect were least important chick reared in battery brooder are slightly heavier than deep litter system. Chicks fed diet D\textsubscript{3} were significant heavier than those chicks offer D\textsubscript{2} and D\textsubscript{1} diet. Body weight in D\textsubscript{2} and D\textsubscript{1}
energy level was also highly significantly different. These results are similar to 1-3rd week body weight. The mean body weight in D₁, D₂ and D₃ were 330.50±4.71, 358.48±4.98 and 372.90±6.04. The D₄ diet containing dried garlic powder which is significant heavier with 16.75 g than D₂ diet. The mean body weight of D₄ diet is 389.65±5.86 g.

**Fifth week body weight**

Body weight mean at 5th week age were highly significant due to housing system. Body weight in battery brooder and deep litter system were 427.33±7.12 g and 406.22±5.52g respectively. Dietary energy level D₁ (2500 ME/kg), D₂ (2700 kcal ME/kg), D₃ (2900 kcal ME/kg) and D₄ (2700 kcal ME/kg + dried garlic powder) significantly influenced body weight of fifth week age. Superiority of different diets followed similar pattern as in 1-4 weeks of age. The D₄ diet containing dried garlic powder is significantly heavier with 15.58g than D₂ diet. The mean body weight of D₄ and D₂ diet is 442.43±8.29 and 415.10±9.06 g.

**Sixth week body weight**

The housing and dietary effect were non significant for pooled sex basis. The H₁ and H₂ housing system mean recorded were 672.87±8.01 and 666.56±8.32g. The body means for different diets were ranged from 645.75±10.53 (D₁) to 682.88±10.82 g (D₄).

**Seventh week body weight**

The housing system were non significant on the contrary dietary effects were highly significant for pooled sex basis. The H₁ and H₂ means recorded were 754.62±7.98 and 737.15±7.26 g. The dietary effect were highly significant, D₃ diet having significantly better body weight 759.63±9.15g than D₂ and D₁ 726.88±9.40 and 720.25±8.64 g. D₄ diet having 2700 kcal ME/kg + garlic powder is significantly heavier 776.80±13.07 body weight than D₂ (2700 kcal ME/kg) 726.88±9.40 g.
Eighth week body weight

The housing system and dietary effects and their interaction were not significant for 8th week body weight. The chicks housed in battery brooder and deep litter there means body weight recorded were 879.06±9.85g and 866.50±8.61g. The body weight for different dietary effect were ranged from 854.63±9.13 due to 2500 kcal ME/kg diet to 897.13±13.66 g due to 2700 kcal ME/kg diet + dried garlic powder.

Mortality

The mortality was not observed during whole experimental period in any group in dual type coloured chicks (25% Kadaknath : 75% Jabalpur colour) reveal 100% livability during day old to 8 weeks of age.

Average total feed intake g/bird/week

A total no. of 160 commercial colour dual chicks were randomly divided into groups of 80 chick each housed in battery brooder and deep litter system in different pens replicate and dietary treatment wise.

These chick were fed ration containing energy level $D_1$ (2500 kcal ME/kg), $D_2$ (2700 kcal ME/kg), $D_3$ (2900 kcal ME/kg) and $D_4$ (2700 kcal ME/kg + dried garlic powder). The daily measured amount of feed was offered sufficient for *ad-libitum* feeding and residual feed after 7th day feeding was recorded for each replicate in each treatment to measure average total weekly feed intake and average total feed intake (FI) per week was estimated. Replicate wise pooled data of feed intake was analyzed in two analysis under completely randomized design to evaluate effect of housing system, energy levels and their interaction. The mean for average total feed intake g/bird/week due to housing system and dietary energy are presented in table 07 to 08 and the interaction mean for feed intake are presented table 09 and graphical presentation in fig 04 to 06 where as mean sum square are presented in table 10.
### Table 07: Effect of housing on feed intake g /bird /week

<table>
<thead>
<tr>
<th>Housing system</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; week</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; week</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; week</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>6&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>7&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>8&lt;sup&gt;th&lt;/sup&gt; week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery brooder (H&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>77.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>117.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>163.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>187.94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>226.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>311.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>278.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>380.79&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Deep litter (H&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>72.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>113.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>156.63&lt;sup&gt;b&lt;/sup&gt;</td>
<td>178.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>213.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>295.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>282.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td>367.29&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>SE for means</td>
<td>±0.18</td>
<td>±0.29</td>
<td>±0.33</td>
<td>±0.36</td>
<td>±0.39</td>
<td>±0.75</td>
<td>±0.30</td>
<td>±0.40</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

### Table 08: Effect of energy levels on feed intake g / bird / week

<table>
<thead>
<tr>
<th>Levels of energy kcal ME /kg</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; week</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; week</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; week</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>6&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>7&lt;sup&gt;th&lt;/sup&gt; week</th>
<th>8&lt;sup&gt;th&lt;/sup&gt; week</th>
</tr>
</thead>
<tbody>
<tr>
<td>D&lt;sub&gt;1&lt;/sub&gt;(2500)</td>
<td>62.62± 3.03</td>
<td>114.62±1.59</td>
<td>154.50±2.50</td>
<td>180.25±3.59</td>
<td>218.37±6.21</td>
<td>289.25±3.73</td>
<td>308.60±2.23</td>
<td>367.50±4.80</td>
</tr>
<tr>
<td>D&lt;sub&gt;2&lt;/sub&gt;(2700)</td>
<td>76.00± 2.04</td>
<td>115.37±1.24</td>
<td>155.62±2.60</td>
<td>181.25±2.97</td>
<td>217.12±3.64</td>
<td>304.62±3.4</td>
<td>284.27±2.56</td>
<td>372.00±4.24</td>
</tr>
<tr>
<td>D&lt;sub&gt;3&lt;/sub&gt;(2900)</td>
<td>86.62±1.24</td>
<td>116.62±0.22</td>
<td>174.50±1.65</td>
<td>190.25±2.49</td>
<td>223.75±1.93</td>
<td>314.87±3.11</td>
<td>272.25±1.60</td>
<td>381.65±3.03</td>
</tr>
<tr>
<td>D&lt;sub&gt;4&lt;/sub&gt;(2700+Garlic)</td>
<td>73.00±1.83</td>
<td>116.75±1.70</td>
<td>155.13±2.04</td>
<td>181.00±2.80</td>
<td>180.00±2.80</td>
<td>305.75±3.40</td>
<td>257.25±0.90</td>
<td>375.00±4.56</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Table 09: Effect of housing ×energy level on feed intake g / bird / week

<table>
<thead>
<tr>
<th>H×D</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁D₁</td>
<td>68.25</td>
<td>117.00</td>
<td>158.75</td>
<td>185.25</td>
<td>229.00</td>
<td>304.75</td>
<td>305.00</td>
<td>375.00</td>
</tr>
<tr>
<td>H₁D₂</td>
<td>78.50</td>
<td>117.50</td>
<td>160.00</td>
<td>186.25</td>
<td>223.00</td>
<td>310.50</td>
<td>282.25</td>
<td>379.00</td>
</tr>
<tr>
<td>H₁D₃</td>
<td>88.50</td>
<td>117.75</td>
<td>176.50</td>
<td>194.50</td>
<td>226.50</td>
<td>320.00</td>
<td>270.50</td>
<td>386.06</td>
</tr>
<tr>
<td>H₁D₄</td>
<td>73.75</td>
<td>119.00</td>
<td>157.75</td>
<td>185.75</td>
<td>226.00</td>
<td>311.50</td>
<td>255.75</td>
<td>382.50</td>
</tr>
<tr>
<td>H₂D₁</td>
<td>61.00</td>
<td>112.25</td>
<td>150.25</td>
<td>175.25</td>
<td>207.75</td>
<td>273.75</td>
<td>312.20</td>
<td>360.60</td>
</tr>
<tr>
<td>H₂D₂</td>
<td>73.50</td>
<td>113.25</td>
<td>151.25</td>
<td>176.25</td>
<td>211.25</td>
<td>298.75</td>
<td>286.30</td>
<td>365.00</td>
</tr>
<tr>
<td>H₂D₃</td>
<td>84.75</td>
<td>115.50</td>
<td>172.50</td>
<td>186.00</td>
<td>221.00</td>
<td>309.75</td>
<td>273.85</td>
<td>376.65</td>
</tr>
<tr>
<td>H₂D₄</td>
<td>72.25</td>
<td>114.50</td>
<td>152.50</td>
<td>176.25</td>
<td>212.75</td>
<td>300.00</td>
<td>258.75</td>
<td>367.50</td>
</tr>
<tr>
<td>SE for means</td>
<td>±1.98</td>
<td>±0.93</td>
<td>±1.22</td>
<td>±1.46</td>
<td>±1.72</td>
<td>±6.43</td>
<td>±1.00</td>
<td>±1.84</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 10: Mean sum of squares for feed intake g / bird /week

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>76.56</td>
<td>62.02**</td>
<td>1.75**</td>
<td>361.00**</td>
<td>669.52**</td>
<td>1040.06*</td>
<td>77.44**</td>
<td>729.00**</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>330.35</td>
<td>4.18</td>
<td>377.85**</td>
<td>89.40**</td>
<td>33.18*</td>
<td>451.62</td>
<td>188.94**</td>
<td>141.02*</td>
</tr>
<tr>
<td>H×D</td>
<td>3</td>
<td>5.77</td>
<td>1.31</td>
<td>5.60</td>
<td>0.50</td>
<td>41.97</td>
<td>98.77</td>
<td>3.68</td>
<td>5.67</td>
</tr>
<tr>
<td>Error</td>
<td>152</td>
<td>15.69</td>
<td>3.47</td>
<td>6.00</td>
<td>8.53</td>
<td>11.86</td>
<td>165.56</td>
<td>4.02</td>
<td>13.49</td>
</tr>
</tbody>
</table>

*Significant at (p< 0.05)  
**Significant at (p< 0.01)
1\textsuperscript{st} week average total feed intake g / bird / week

During 1\textsuperscript{st} week of age feed intake was more or less similar in battery brooder and deep litter system feed intake. Feeding during 1\textsuperscript{st} week in D\textsubscript{1}, D\textsubscript{2}, D\textsubscript{3} and D\textsubscript{4} dietary level was 62.62±0.03, 76.00±2.04, 86.62±1.24 and 73.00±1.83 g. Feed intake was significantly lower in D\textsubscript{1} diet and highly significantly different from D\textsubscript{4} and D\textsubscript{2} diets and D\textsubscript{2} and D\textsubscript{4} are significantly differ than D\textsubscript{3} diet, however the D\textsubscript{4} and D\textsubscript{2} diets having similar feed consumption.

Interaction effect between housing system i.e. battery brooder and deep litter system with different dietary treatment were non significant from 1\textsuperscript{st} week to 8\textsuperscript{th} week of age.

2\textsuperscript{nd} week average total feed intake g / bird / week

During second week of age feed intake was highly significant in battery brooder and deep litter system. Feed intake in deep litter system was 113.87g and in battery brooder was 117.81 g. Feed intake during second week of age was non significant due to different dietary treatment, the mean value ranged from 114.62±1.59 to 116.75±1.70 g.

3\textsuperscript{rd} week average total feed intake g / bird / week

During 3\textsuperscript{rd} week of age feed intake was highly significant in battery brooder and deep litter system. The chicks kept in deep litter consumed less feed (156.63 g) which is lesser than battery brooder chicks. Feed intake during this period was highly significant due to different dietary treatments where as in second week they were non significant. D\textsubscript{1}, D\textsubscript{2} and D\textsubscript{4} dietary treatment group chicks consumed more or less similar feed and quantity was highly significant lesser than D\textsubscript{3} diet. Average feed intake for D\textsubscript{1}, D\textsubscript{2}, D\textsubscript{3} and D\textsubscript{4} diet was 154.5, 155.62, 174.5 and 155.13 g per bird / week.
**4th week average total feed intake g / bird / week**

Analysis of variance revealed similar results with 3rd week feed intake. In 4th week H1 and H2 housing system chicks consumed 187.94g and 178.44 g. D3 groups chicks consumed 190.25±2.49 g per bird / week which is significantly higher than D1, D2 and D4. The feed intake was more or less similar 5th week average total feed intake g/ bird / week.

**5th week average total feed intake g / bird / week**

During 5th week of age feed intake was highly significant in battery brooder than deep litter system. The means value was 226.13 and 213.19 g / bird / week respectively. Feed intake during this period was highly significant due to different dietary treatment and the trend was similar to 4th week of age. The mean value of different dietary treatment i.e. D1, D2, D3 and D4 were 218.37, 217.12, 223.75 and 180.00 g respectively.

**6th week average total feed intake g / bird / week**

During 6th week of age average feed intake was high significant in battery brooder than deep litter system. The means value was lesser in deep litter system than battery brooder, mean values were 295.56 and 311.69 g respectively. Feed intake during this period was not significant due to different dietary treatment groups and trend was similar to 2nd week of age.

**7th week average total feed intake g / bird / week**

During 7th week of age feed intake was highly significant due to housing system and different dietary treatment. The chicks kept in deep litter consumed more feed than chicks kept in battery brooder the average total feed intake g / bird / week was 282.72 and 278.38 g respectively. The different dietary treatment group chicks consumed progressively less feed as the energy level of different diet increases and additional dried garlic powder. The dietary treatment wise mean values were 308.60±2.23, 284.27±2.56, 272.25±1.60, 257.25±0.90 from D1 to D4 diets respectively.
8th week average total feed intake g / bird / week

During 8th week of age feed intake was also highly significant due to housing system as in 7th week but the chicks kept in cages (H1) consumed more feed i.e. 380.79 g and H2 groups chicks consumed 367.29 g. The different dietary groups are also highly significantly different among themselves. D1 and D2 diet consumed significantly less feed than D3 and D4 diet and D2 and D4 dietary groups chicks consumed more or less similar feed but D3 dietary groups chicks consumes highly significant more feed than D2 and D4 dietary groups.

Cumulative feed intake (g/bird 1-8 week of age)

Analysis of variance for cumulative feed intake/bird revealed that housing effect and dietary effect were highly significant but housing system x dietary system interaction were non significant. Chicks kept in deep litter housing system consumed significantly less feed than the chick kept in battery brooder. The average cumulative feed intake per/bird for 0-8th weeks of age was 1680.68±13.60 and 1743.22±12.33 g respectively.

D4 dietary groups significantly feed less than D3, D2 and D1 dietary groups chicks. D3 dietary groups feed more than D2 and D1 but D2 and D1 consumed more or less similar feed. The means values for D1, D2, D3 and D4 dietary groups were 1697.72±31.28, 1706.27±17.75, 1760.57±11.95 and 168.25±16.98 g respectively.

Feed efficiency

Replicate wise cumulative feed efficiency as feed conversion ratio of commercial coloured dual chicks were measured for each treatment on the basis of total feed consumed and total weight gain during experimental period, and statistically analyzed to observed effect of housing system and dietary treatment and their interaction on feed conversion efficiency mean. Feed efficiency due to housing system, dietary treatment and their interaction effect is presented in table 11 to 13.
### Table 11: Overall effect of housing on feed intake and feed conversion ratio (FCR) at 8th week

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Average total feed intake /bird 0-8 week of age</th>
<th>Cumulative FCR /bird 0-8 week of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery brooder (H₁)</td>
<td>1743.22b±12.23</td>
<td>2.06±0.03</td>
</tr>
<tr>
<td>Deep litter (H₂)</td>
<td>1680.68a±13.60</td>
<td>2.04±0.04</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

### Table 12: Overall effect of energy on feed intake and feed conversion ratio (FCR) at 8th week

<table>
<thead>
<tr>
<th>Level of energy (kcal ME/Kg)</th>
<th>Average total feed intake g /bird 1-8 week of age</th>
<th>Cumulative FCR /bird 1-8 week of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁(2500)</td>
<td>1697.72b±31.28</td>
<td>2.06±0.06</td>
</tr>
<tr>
<td>D₂(2700)</td>
<td>1706.27b±17.75</td>
<td>2.11±0.03</td>
</tr>
<tr>
<td>D₃(2900)</td>
<td>1760.57a²±11.95</td>
<td>2.09±0.02</td>
</tr>
<tr>
<td>D₄(2700+Garlic)</td>
<td>1683.25c²±16.98</td>
<td>1.95±0.02</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

### Table 13: Effect of housing × energy levels interaction on feed intake and FCR at 8th week

<table>
<thead>
<tr>
<th>HxD</th>
<th>Average total feed intake g /bird 1-8 week of age</th>
<th>Cumulative FCR /bird 1-8 week of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁D₁</td>
<td>1743.00±41.60</td>
<td>2.119±0.137</td>
</tr>
<tr>
<td>H₁D₂</td>
<td>1737.00±0.10</td>
<td>2.099±0.001</td>
</tr>
<tr>
<td>H₁D₃</td>
<td>1780.90±5.30</td>
<td>2.075±0.021</td>
</tr>
<tr>
<td>H₁D₄</td>
<td>1712.00±1.60</td>
<td>1.985±0.003</td>
</tr>
<tr>
<td>H₂D₁</td>
<td>1652.45±6.35</td>
<td>2.005±0.053</td>
</tr>
<tr>
<td>H₂D₂</td>
<td>1675.55±1.85</td>
<td>2.139±0.082</td>
</tr>
<tr>
<td>H₂D₃</td>
<td>1740.25±1.65</td>
<td>2.114±0.021</td>
</tr>
<tr>
<td>H₂D₄</td>
<td>1654.50±8.70</td>
<td>1.928±0.023</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Analysis of variance is present in table 14. Graphical is present in fig 07 to 09 chicks reared in battery brooder and deep litter housing system did not exerted significant effect on feed conversion efficiency of chicks. Chicks reared in deep litter showed better feed conversion ratio than the battery brooder. The mean values were 2.04±0.04 and 2.06±0.03 kg feed consumed /kg body weight gain.

**Table 14: Mean sum of squares for over all feed intake and FCR (1-8 week)**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Feed intake (g)/bird</th>
<th>FCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>15643.75**</td>
<td>0.002</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>4563.51**</td>
<td>0.020</td>
</tr>
<tr>
<td>HxD</td>
<td>3</td>
<td>430.10</td>
<td>0.006</td>
</tr>
<tr>
<td>Error</td>
<td>152</td>
<td>470.84</td>
<td>0.007</td>
</tr>
</tbody>
</table>

*Significant at (p < 0.05)
**Significant at (p < 0.01)

High dietary energy D₄ (2700 kcal ME/kg + garlic powder) revealed better feed efficiency than D₁ (2.06±0.06), D₃ (2.09±0.02) and D₂ (2.11±0.03), however the different level of energy and 2700 kcal ME/kg added with dried garlic powder and 750 g /quintal feed did not show significant effect.

Housing x dietary treatment interaction unable to show significant effect on feed conversion ratio, however H₁D₄ dietary group chicks consumed 1.985±0.03kg feed /kg body gain during the 8th weeks experimental period. On contrary H₂D₂ treatment interaction groups consumed 2.139±0.082 kg feed/kg of weight gain during the same experimental period.

**Conformation traits**

The conformation traits such as breast angle, keel length and shank length were measured on individual bird basis at 8th week age on all the chicks under study. Data were analyzed for housing effect, dietary treatment and there interaction effect on pooled over sex basis. The means along with standard error are present in table 15 to 17, whereas mean sum of squares from analysis of variance for these trait are presented in table 18.
Table 15: Effect of housing on conformation traits at 8th week of age

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Breast angle (°)</th>
<th>Keel length (cm)</th>
<th>Shank length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁ (Battery brooder)</td>
<td>51.4±0.316</td>
<td>7.96±0.06</td>
<td>7.45±0.049</td>
</tr>
<tr>
<td>H₂ (deep litter)</td>
<td>48.8±0.353</td>
<td>7.92±0.04</td>
<td>7.44±0.046</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 16: Effect of energy on conformation traits at 8th week of age

<table>
<thead>
<tr>
<th>Level of energy Kcal ME/Kg</th>
<th>Breast angle (°)</th>
<th>Keel length (cm)</th>
<th>Shank length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁ (2500)</td>
<td>48.35±0.55</td>
<td>7.94±0.06</td>
<td>7.43±0.05</td>
</tr>
<tr>
<td>D₂ (2700)</td>
<td>49.20±0.54</td>
<td>7.89±0.08</td>
<td>7.41±0.09</td>
</tr>
<tr>
<td>D₃ (2900)</td>
<td>51.63±0.42</td>
<td>7.81±0.06</td>
<td>7.40±0.05</td>
</tr>
<tr>
<td>D₄ (2700+Garlic)</td>
<td>51.23±0.33</td>
<td>7.95±0.6</td>
<td>7.56±0.08</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 17: Effect of housing and energy levels interaction on conformation traits at 8th week of age

<table>
<thead>
<tr>
<th>H×D</th>
<th>Breast angle (°)</th>
<th>Keel length (cm)</th>
<th>Shank length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁D₁</td>
<td>51.10abc ±0.53</td>
<td>7.86±0.09</td>
<td>7.33±0.07</td>
</tr>
<tr>
<td>H₁D₂</td>
<td>49.85cd ±0.50</td>
<td>7.92±0.10</td>
<td>7.52±0.07</td>
</tr>
<tr>
<td>H₁D₃</td>
<td>52.70a ±0.43</td>
<td>7.84±0.08</td>
<td>7.46±0.07</td>
</tr>
<tr>
<td>H₁D₄</td>
<td>51.95ab ±0.60</td>
<td>7.42±0.08</td>
<td>7.51±0.06</td>
</tr>
<tr>
<td>H₂D₁</td>
<td>45.60b ±0.84</td>
<td>8.03±0.10</td>
<td>7.52±0.10</td>
</tr>
<tr>
<td>H₂D₂</td>
<td>48.55d ±0.43</td>
<td>7.87±0.09</td>
<td>7.31±0.14</td>
</tr>
<tr>
<td>H₂D₃</td>
<td>50.55bc ±0.68</td>
<td>7.78±0.12</td>
<td>7.34±0.14</td>
</tr>
<tr>
<td>H₂D₄</td>
<td>50.50bc ±0.46</td>
<td>8.01±0.08</td>
<td>7.62±0.06</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Table 18: Mean sum of squares for conformation trait at 8\textsuperscript{th} week of age

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Breast angle(°)</th>
<th>Keel length (cm)</th>
<th>Shank length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>270.40**</td>
<td>3053.49</td>
<td>0.00</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>99.52**</td>
<td>3108.67</td>
<td>0.23</td>
</tr>
<tr>
<td>H×D</td>
<td>3</td>
<td>38.75**</td>
<td>3066.66</td>
<td>0.36</td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>6.59</td>
<td>3057.95</td>
<td>0.18</td>
</tr>
</tbody>
</table>

*Significant at (p< 0.05)
**Significant at (p< 0.01)

Chicks kept in battery brooder revealed significantly higher breast angle than chicks kept in deep litter system. However housing system do not show significant effect for keel length and shank length. Mean values for breast angle keel length and shank length were 51.4±0.316, 7.96±0.06 and 7.45±0.049 for chicks kept in battery brooder where as 48.8±0.35, 7.92±0.04 cm and 7.44±0.046 respectively for deep litter system.

Different dietary treatment effect was significant only for breast angle but non significant for keel length and shank length.

D\textsubscript{3} and D\textsubscript{4} diets having more or less similar breast angle, the mean value was 51.63±0.42 and 51.23±0.33 degree. These mean values are significantly higher than D\textsubscript{1} (48.35±0.55) and D\textsubscript{2} (49.20±0.54) and these mean value of D\textsubscript{1} and D\textsubscript{2} did not differed significantly.

D\textsubscript{4} diet group chicks have longer keel length and shank length which was 7.95±0.6 and 7.56±0.08 cm respectively. Other dietary group has more or less similar keel length and shank length.

Housing system x dietary interaction was significant for breast angle but not significant for keel length and shank length.

Interaction effect mean show's that \textit{H1D3} treatment groups birds having wider breast angle of 52.70±0.43 degree. \textit{H2D1} treatment group chicks
keel length was 8.03±0.10 cm which is largest among other interaction treatment groups whereas H₂D₄ treatment group posses longest shank length of 7.62±0.06 cm. The interaction treatment mean for keel length and shank length were more or less similar.

H₁D₃, H₁D₄ and H₁D₁ interaction means were non significant, similarly H₁D₁, H₁D₄, H₂D₃ and H₂D₄ interaction means and H₁D₁, H₁D₂, H₂D₃ and H₂D₄ were not significant among themselves. The H₁D₂ and H₂D₂ were also non significantly different. They are significantly different than H₂D₁.

**Carcass traits**

At 8th week of age two males from each treatment were randomly picked up for evaluation of carcass traits as influenced by housing system, dietary energy levels and dried garlic powder and their interactions.

The measured carcass traits were determined as percent of starved weight and cut-up yields as percent of eviscerated weight. The total over all means of carcass traits of males are presented in the table 19 to 21. The analyses of variance for carcass for male are presented in table 22. Percent cut-up yield of male are presented in table 23 to 25, and analysis of variance is presented in table 26.
Table 19: Effect of housing on carcass traits at 8th week of age

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Starved wt (g)</th>
<th>Shrinkage (%)</th>
<th>Blood loss (%)</th>
<th>Feather loss (%)</th>
<th>Eviscerated yield (%)</th>
<th>Giblet (%)</th>
<th>Abd. Fat (%)</th>
<th>TMY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery brooder (H₁)</td>
<td>949.23±17.72</td>
<td>5.20±1.05</td>
<td>7.77±1.43</td>
<td>4.43±0.64</td>
<td>64.81±1.78</td>
<td>5.74±0.25</td>
<td>0.53±0.09</td>
<td>70.55±1.90</td>
</tr>
<tr>
<td>Deep litter (H₂)</td>
<td>928.91±13.67</td>
<td>3.99±0.54</td>
<td>8.53±1.59</td>
<td>4.31±0.63</td>
<td>63.38±1.22</td>
<td>5.55±0.15</td>
<td>0.52±0.12</td>
<td>68.93±1.29</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 20: Effect of dietary energy on carcass traits at 8th week of age

<table>
<thead>
<tr>
<th>Level of energy Kcal ME/Kg</th>
<th>Starved wt (g)</th>
<th>Shrinkage (%)</th>
<th>Blood loss (%)</th>
<th>Feather loss (%)</th>
<th>Eviscerated yield (%)</th>
<th>Giblet (%)</th>
<th>Abd. Fat (%)</th>
<th>TMY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁2500</td>
<td>901.32±6.40</td>
<td>4.09±0.63</td>
<td>11.85±1.47</td>
<td>3.38±0.76</td>
<td>61.61±0.42</td>
<td>5.16±0.26</td>
<td>0.72±0.15</td>
<td>66.78±0.66</td>
</tr>
<tr>
<td>D₂2700</td>
<td>939.10±11.02</td>
<td>3.68±0.78</td>
<td>8.21±2.18</td>
<td>4.61±1.01</td>
<td>63.33±1.94</td>
<td>5.73±0.30</td>
<td>0.51±0.06</td>
<td>69.06±2.06</td>
</tr>
<tr>
<td>D₃2900</td>
<td>925.95±25.18</td>
<td>6.89±1.82</td>
<td>5.36±1.56</td>
<td>4.36±1.08</td>
<td>67.36±2.39</td>
<td>6.11±0.25</td>
<td>0.72±0.10</td>
<td>73.47±2.61</td>
</tr>
<tr>
<td>D₄2700+Garlic</td>
<td>989.92±16.87</td>
<td>3.72±0.61</td>
<td>7.19±2.18</td>
<td>5.15±0.70</td>
<td>64.08±2.64</td>
<td>5.58±0.23</td>
<td>0.16±0.01</td>
<td>69.66±2.53</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
<table>
<thead>
<tr>
<th>H×D</th>
<th>Starved wt (g)</th>
<th>Shrinkage (Starved wt (g))</th>
<th>Blood loss (%)</th>
<th>Feather loss (%)</th>
<th>Eviscerated yield (%)</th>
<th>Giblet (%)</th>
<th>Abd. Fat (%)</th>
<th>TMY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁D₁</td>
<td>898.50±0.50</td>
<td>4.64±1.31</td>
<td>11.57±2.34</td>
<td>4.19±1.27</td>
<td>61.75±0.19</td>
<td>5.19±0.21</td>
<td>0.71±0.23</td>
<td>66.95±0.01</td>
</tr>
<tr>
<td>H₁D₂</td>
<td>938.30±26.50</td>
<td>4.51±1.48</td>
<td>5.98±0.76</td>
<td>6.03±0.33</td>
<td>61.81±1.09</td>
<td>5.87±0.72</td>
<td>0.62±0.03</td>
<td>70.69±1.82</td>
</tr>
<tr>
<td>H₁D₃</td>
<td>955.50±33.50</td>
<td>7.40±4.37</td>
<td>4.31±2.25</td>
<td>3.22±2.10</td>
<td>70.51±3.43</td>
<td>6.39±0.47</td>
<td>0.64±0.05</td>
<td>76.90±3.90</td>
</tr>
<tr>
<td>H₁D₄</td>
<td>1004.65±34.15</td>
<td>4.25±1.30</td>
<td>9.24±3.83</td>
<td>4.30±1.21</td>
<td>62.17±5.19</td>
<td>5.50±0.53</td>
<td>0.16±0.01</td>
<td>67.68±4.66</td>
</tr>
<tr>
<td>H₂D₁</td>
<td>904.15±15.15</td>
<td>3.54±0.34</td>
<td>12.13±2.73</td>
<td>2.57±0.78</td>
<td>61.46±0.99</td>
<td>5.14±0.60</td>
<td>0.73±0.30</td>
<td>66.60±1.59</td>
</tr>
<tr>
<td>H₂D₂</td>
<td>939.90±5.1</td>
<td>2.84±0.27</td>
<td>10.45±4.25</td>
<td>3.18±1.41</td>
<td>61.84±4.13</td>
<td>5.59±0.01</td>
<td>0.40±0.01</td>
<td>67.44±4.11</td>
</tr>
<tr>
<td>H₂D₃</td>
<td>896.40±30.60</td>
<td>6.39±0.51</td>
<td>6.41±2.71</td>
<td>5.49±0.12</td>
<td>64.21±1.62</td>
<td>5.83±0.12</td>
<td>0.80±0.21</td>
<td>70.05±1.50</td>
</tr>
<tr>
<td>H₂D₄</td>
<td>975.20±10.40</td>
<td>3.20±0.17</td>
<td>5.14±2.35</td>
<td>6.00±0.24</td>
<td>65.99±2.71</td>
<td>5.66±0.17</td>
<td>0.16±0.01</td>
<td>71.65±2.96</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Table 22: Mean sum of squares for carcass trait of male

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Starved wt (g)</th>
<th>Shrinkage (%)</th>
<th>Blood loss (%)</th>
<th>Feather loss (%)</th>
<th>Eviscerated yield (%)</th>
<th>Giblet (%)</th>
<th>Abd. Fat (%)</th>
<th>TMY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>1652.42</td>
<td>5.84</td>
<td>2.30</td>
<td>0.06</td>
<td>8.24</td>
<td>0.13</td>
<td>0.00</td>
<td>10.49</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>5577.40*</td>
<td>9.50</td>
<td>29.87</td>
<td>2.19</td>
<td>23.25</td>
<td>0.61</td>
<td>0.27*</td>
<td>30.91</td>
</tr>
<tr>
<td>H×D</td>
<td>3</td>
<td>914.05</td>
<td>0.09</td>
<td>13.07</td>
<td>6.23</td>
<td>18.27</td>
<td>0.09</td>
<td>0.02</td>
<td>20.91</td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>1072.75</td>
<td>6.30</td>
<td>16.06</td>
<td>2.58</td>
<td>17.15</td>
<td>0.37</td>
<td>0.04</td>
<td>17.72</td>
</tr>
</tbody>
</table>

*Significant at (p< 0.05)
**Significant at (p< 0.01)

Table 23: Effect of housing on cut up carcass yield of male

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Breast weight (%)</th>
<th>Leg weight (%)</th>
<th>Wing weight (%)</th>
<th>Back with neck (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery brooder(H₁)</td>
<td>22.05±0.61</td>
<td>32.08±0.44</td>
<td>14.61±0.26</td>
<td>31.12±0.44</td>
</tr>
<tr>
<td>Deep litter(H₂)</td>
<td>22.85±0.71</td>
<td>31.87±0.26</td>
<td>14.93±0.36</td>
<td>30.36±0.27</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 24: Effect of dietary energy levels on cut up carcass yield of male

<table>
<thead>
<tr>
<th>Level of energy Kcal ME/Kg</th>
<th>Breast weight (%)</th>
<th>Leg weight (%)</th>
<th>Wing weight (%)</th>
<th>Back with neck (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁(2500)</td>
<td>22.31±0.47</td>
<td>32.14±0.53</td>
<td>14.79±0.28</td>
<td>30.88±0.72</td>
</tr>
<tr>
<td>D₂(2700)</td>
<td>22.58±0.64</td>
<td>31.74±0.38</td>
<td>14.99±0.38</td>
<td>30.41±0.43</td>
</tr>
<tr>
<td>D₃(2900)</td>
<td>20.43±0.67</td>
<td>32.89±0.39</td>
<td>15.19±0.45</td>
<td>31.45±0.53</td>
</tr>
<tr>
<td>D₄(2700+Garlic)</td>
<td>24.49±0.70</td>
<td>31.14±0.39</td>
<td>14.11±0.58</td>
<td>32.22±0.40</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)
Table 25: Effect of housing × energy on cut up carcass yield of male

<table>
<thead>
<tr>
<th>Factor</th>
<th>Breast weight (%)</th>
<th>Leg weight (%)</th>
<th>Wing weight (%)</th>
<th>Back with neck (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁D₁</td>
<td>21.58±0.51</td>
<td>32.40±1.20</td>
<td>14.39±0.36</td>
<td>31.67±1.28</td>
</tr>
<tr>
<td>H₁D₂</td>
<td>22.88±1.14</td>
<td>31.59±0.66</td>
<td>15.22±0.43</td>
<td>29.79±0.47</td>
</tr>
<tr>
<td>H₁D₃</td>
<td>19.91±0.41</td>
<td>33.19±0.81</td>
<td>14.66±0.65</td>
<td>32.21±0.24</td>
</tr>
<tr>
<td>H₁D₄</td>
<td>23.85±0.35</td>
<td>31.14±0.74</td>
<td>14.16±0.80</td>
<td>30.80±0.40</td>
</tr>
<tr>
<td>H₂D₁</td>
<td>23.04±0.07</td>
<td>31.88±0.35</td>
<td>15.18±0.15</td>
<td>30.09±0.49</td>
</tr>
<tr>
<td>H₂D₂</td>
<td>22.29±1.01</td>
<td>31.88±0.61</td>
<td>14.76±0.74</td>
<td>31.03±0.34</td>
</tr>
<tr>
<td>H₂D₃</td>
<td>20.96±1.41</td>
<td>32.60±0.25</td>
<td>15.73±0.46</td>
<td>30.69±0.69</td>
</tr>
<tr>
<td>H₂D₄</td>
<td>25.13±1.43</td>
<td>31.14±0.63</td>
<td>14.06±1.16</td>
<td>29.64±0.34</td>
</tr>
</tbody>
</table>

Mean having different superscript in a column differ significant (p<0.05)

Table 26: Mean sum of squares for carcass cut up parts of male

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Breast (%)</th>
<th>Leg (%)</th>
<th>Wing (%)</th>
<th>Back with neck (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>2.56</td>
<td>0.16</td>
<td>0.41</td>
<td>2.26</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>11.04*</td>
<td>2.16</td>
<td>0.88</td>
<td>1.20</td>
</tr>
<tr>
<td>H×D</td>
<td>3</td>
<td>0.88</td>
<td>0.17</td>
<td>0.52</td>
<td>1.80</td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>1.73</td>
<td>8.10</td>
<td>7.05</td>
<td>6.11</td>
</tr>
</tbody>
</table>

*Significant at (p< 0.05)
**Significant at (p< 0.01)

The effect of housing system, dietary energy levels on carcass traits are also depicted by Fig 16 to 18 for male and graphical presentation for cut up carcass yields are shown in Fig 19 to 21.
Inedible parts

Analysis of variance for inedible parts shrinkage, blood loss, feather loss, non significant for housing system, dietary energy level and housing × dietary interaction effect only significant effect due to different dietary levels were observed for abdominal fat %. On the contrary housing effect and interaction between housing effect and dietary levels were also non significant.

Starved live body weight

Starved live body weight was not significant for housing system and interaction of housing × dietary energy levels but significant for dietary energy levels. In housing system battery brooder (H₁) have heavier starved body weight than the deep litter system (H₂) i.e. 949.23±17.7 and 928.91±13.6 g.

D₄ treatment group was significantly different than D₃, D₂ and D₁. However D₃ was not significant with D₂. The difference between D₃ and D₂ with D₁ was also significant. Starved weight for D₄, D₃, D₂ and D₁ diet was 989.92±16.87, 925.95±25.18, 939.10±11.02 and 901.32±6.40 g.

Percent shrinkage

Percent shrinkage loss is observed high in D₁ (2500 kcal ME/kg) and D₃ (2900 kcal ME/kg) i.e. 4.09±0.63 and 6.89±1.82 g due to different energy levels, but lesser in D₂ and D₄.

Percent blood loss

In housing system higher blood loss was recorded in battery brooder than the deep litter system i.e. 8.53±1.59 % and 7.77±1.43 % of body weight respectively. The means for blood loss percent in dietary treatment were D₁ (11.85±1.47), D₂ (8.21±2.18), D₃ (5.36±1.56) and D₄ (7.19±2.18). The higher blood loss was recorded in D₁ (2500 kcal ME/kg) groups.
Percent feather loss

The feather loss was more in males kept in battery brooder (4.43±0.64). Feather loss varied from 3.38 – 5.15% in different dietary treatments.

Edible parts

Analysis of variance for edible parts like eviscerated yield per cent, giblet per cent and total meat yield per cent were non significant for housing system, dietary treatments and their interactions. Only dietary effect was significant for abdominal fat per cent.

Percent eviscerated yield

Eviscerated yield in males for housing system was 64.81% and 63.38% showed non significant difference. Similarly yield in dietary energy levels D₁ (61.61%), D₂ (63.61%), D₃ (67.36%) and D₄ (64.08%) was not significantly different.

Percent giblet yield

The effects of dietary energy levels also show non significant difference among all treatments and D₃ (2900kcalME/kg) had more percent giblet yield i.e. 6.11%.

Percent abdominal fat

Abdominal fat % was highly affected 0.16±0.01 males fed with D₄ diet containing 2700 kcal ME/kg energy and dried garlic powder than D₂ diet (2700 kcal ME/kg) having 0.51±0.06 %.Both D₂ and D₄ diets are significantly different than D₁ and D₃ diet, and these two diets had similar abdominal fat % (0.72±0.15 and 0.72±0.10) respectively. It can be concluded from the present study that 2700kcal ME/kg along with garlic powder treatment group males having least abdominal fat percent.
Percent total meat yield

Males kept in battery brooder have slightly more (70.55%) total meat yield. Total meat yield percent in different dietary treatment ranged 66.78±0.66 (D1) to 73.43±2.61 % (D3)

Cut-up parts yield

The effect of housing system on cut-up parts showed non significant difference for all cut-up parts of male. The effect of dietary energy levels showed significant difference on breast % and show non significant difference for leg %, wing% and back with neck %. The mean value D1 (22.31±0.47%) differ significantly from D3 and D4 dietary energy levels i.e. D3 (20.43%) and D4 (24.49%) however more breast % was recorded in D4 i.e. 24.49%. D1 and D2 dietary treatment means for TMY% were non significant. The effect of interaction on housing × energy levels show non significant difference among all traits.

The effect of housing system on leg %, wing % and back with neck % show non significant difference effect whereas dietary energy levels also show same trend and have non significant different in all dietary energy levels. Interaction effect due to housing system and dietary treatment were not significant for breast, leg, wing and back with neck %.
Table 27: Economics of different diets for commercial dual purpose coloured birds

<table>
<thead>
<tr>
<th>Housing system</th>
<th>Treatments</th>
<th>Body weight (g)</th>
<th>Total feed consumption /bird(g)</th>
<th>Feed cost(Rs/kg)</th>
<th>Total feed cost(Rs)</th>
<th>Chick cost(Rs/chick)</th>
<th>Total chick and feed cost</th>
<th>Sale rate Rs 90/kg</th>
<th>Income over chick and feed cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁</td>
<td>D₁</td>
<td>856.25</td>
<td>1743</td>
<td>26.61</td>
<td>46.38</td>
<td>17</td>
<td>63.38</td>
<td>77.04</td>
<td>13.66</td>
</tr>
<tr>
<td></td>
<td>D₂</td>
<td>861.25</td>
<td>1737</td>
<td>25.88</td>
<td>44.95</td>
<td>17</td>
<td>61.95</td>
<td>77.4</td>
<td>15.45</td>
</tr>
<tr>
<td></td>
<td>D₃</td>
<td>896.3</td>
<td>1780</td>
<td>26.43</td>
<td>47.05</td>
<td>17</td>
<td>64.05</td>
<td>80.6</td>
<td>16.55</td>
</tr>
<tr>
<td></td>
<td>D₄</td>
<td>902.5</td>
<td>1712</td>
<td>26.38</td>
<td>45.16</td>
<td>17</td>
<td>62.16</td>
<td>81.18</td>
<td>19.02</td>
</tr>
</tbody>
</table>

| H₂             | D₁         | 853             | 1652.45                         | 26.61           | 43.97               | 17                   | 60.97                    | 76.77           | 15.80                         |
|                | D₂         | 857.25          | 1675.55                         | 25.88           | 43.36               | 17                   | 60.36                    | 77.13           | 16.77                         |
|                | D₃         | 864             | 1740                            | 26.43           | 45.99               | 17                   | 62.99                    | 77.76           | 14.77                         |
|                | D₄         | 891.75          | 1654                            | 26.38           | 43.63               | 17                   | 60.63                    | 80.19           | 19.56                         |

* Sale rate commercial dual purpose coloured bird @ Rs. 90/kg
**Economics**

On the basis of housing effect × dietary treatments means of body weight based on pooled over sex basis total feed consumption of birds for 8 week and feed cost Rs/kg, chick cost and income over feed cost was estimated. The prevalence sale rate at the termination of present study was Rs 90/kg for commercial dual purpose coloured birds was utilized for estimating income over feed cost (Rs/kg). The income over feed cost for housing system × dietary mean range from 13.66 to 19.56 in table 27.

The housing system bird when average over 4 diets fetched income of Rs 16.17 in H₁ and H₂ housing system bird produced income of Rs 16.72. The two housing system average over different diet produced income over chick and feed cost 14.73, 16.11, 15.66 and 19.29 for D₁, D₂, D₃ and D₄ diets respectively. The highest income was produced by H₁D₄ diet followed by H₂D₂ diet.
5. DISCUSSION

The body weights during growing period indicate not only its genetic makeup for the fate of cellular development but also its physiological adoptability to specific environment such as nutrition, climate, managerial factor, disease prevalence etc.

**Housing effect:**

The mean body weight of chicks raised in battery brooder and deep litter systems were significantly different for 1\textsuperscript{st} to 5\textsuperscript{th} weeks of age except for 4\textsuperscript{th} week of age. At 5\textsuperscript{th} week of age the chicks were significantly heavier in the battery brooder, their trends is continue upto 8\textsuperscript{th} week of age though statistically non significant for day old, 4\textsuperscript{th} week and 6-8\textsuperscript{th} week of age.

Similar to present study Akhtar (2007) concluded that weight of the hens kept in cages were significantly superior than deep litter hens in the 44 weeks of age, however body weight of hens kept in cages and deep litter were non significant in first day to 32 and 44 weeks of age.

On the contrary Johari et. al. (1984) reported that body weight in deep litter was higher as compare to cage birds.

**Dietary Effect:**

Analysis of variance of body weight at different ages (day old – 8\textsuperscript{th} week of age) revealed highly significant difference due to 4 different diet levels, however body weight at day old, 6\textsuperscript{th} and 8\textsuperscript{th} week age were non significant. At seventh week of age D\textsubscript{3} & D\textsubscript{4} dietary groups weighed more or less similar (776.80 and 759.63g) respectively. Their body weight were significantly differed than that of D\textsubscript{2} and D\textsubscript{1} diets (726.88 and 720.25g). Similar trends were also observed for 8\textsuperscript{th} week though they were statistically non significant.

Diet containing 2700 kcal ME/kg diet along with dried garlic powder had significantly better body weight than diet having 2700 Kcal ME/kg diet (D\textsubscript{2}). The results suggested that inclusion of dried garlic powder enhances
the body weight. The body weight at day old, 6th and 8th week of age did not influenced by dietary energy level in the present study. This result is in agreement with the report of Singh (2013) who reported that dietary energy effect was non significant indicated lower energy needs of coloured dual chicks at 8th week of age, however on the contrary at other ages in present studies revealed significant effect for different dietary energy level particularly at 2nd to 5th week and 7th weeks of age.

Similar to present study Ramarao et al. (2005) concluded that at 42 days of age the body weight reduce significantly in group fed diet containing ME below 2400 kcal ME/kg diet.

Rajpura et al. (2010) reported significant dietary treatment effect on body weight, they observed that chicks fed high energy irrespective of protein levels has highest body weight.

Summers and Leeson (1984) reported that dietary energy level exert little effect on weight gain for male whereas female appear to response increase in weight with energy levels in diet.

Shyamsunder et al. (1988) reported on significant effect on growth upto 3 week period at high & medium energy diet, weight gain was similar but better than low energy diet.

**Interaction Effect:**

**Housing System x dietary interaction effect:-**

Analysis of variance revealed that housing x dietary interaction were non significant irrespective of age from day old of 8th week of age. In battery brooder and deep litter system as energy level increase from 2500-2900kcal ME/kg diet. It is observed that body weight were increased although the difference were statistically non significant.
Feed Intake:

The analysis of variance for feed intake g/bird/week differed significantly at 2\textsuperscript{nd} to 8\textsuperscript{th} week of age. The mean values of feed intake g/bird/week were higher in chicks kept in battery brooder than the deep litter. Similar finding was observed for average total feed intake/bird 1-8\textsuperscript{th} week of age, the means for battery brooder (H\textsubscript{1}) 1743.22\pm12.33 (g) and for deep litter (H\textsubscript{2}) was significantly less and was 1680.68 \pm13.60 (g).

Dietary Effect:

Feed intake g/bird/week was significantly differed at 3\textsuperscript{rd}, 4\textsuperscript{th} and 7\textsuperscript{th} week in different dietary treatment whereas significant at 5\textsuperscript{th} and 8\textsuperscript{th} week of age at different dietary treatment. D\textsubscript{3} (2900kcal/ME/kg diet) showed mostly significant higher feed intake as compared to D\textsubscript{1} and D\textsubscript{2}. The D\textsubscript{4} (2700kcal/ME/kg + garlic) differed non significantly during entire experimental period 1-8 weeks than D\textsubscript{2} (2700kcal/ME/kg diet) except at 7\textsuperscript{th} weeks of age, the mean for dietary energy level. D\textsubscript{3} (2900kcal/ME/kg diet) 1760.57\pm11.95 differed significantly as compared to D\textsubscript{2} (2700kcal/ME/kg) 1706.27\pm17.75 and D\textsubscript{1} (2500kcal/ME/kg) 1697.72\pm31.28. D\textsubscript{4} (2700kcal/ME/kg + garlic) dietary group chicks consumed less average total fed intake g/bird 0-8 weeks for cumulative feed intake g/bird 0-8 week of age,

Javandel et al. (2008) observed that feeding garlic at level of 0.125 and 0.25% resulted in higher feed intake during the starter phase of broiler. Their report is not in agreement with the present findings. They further reported that although the same levels were not efficacious during the growing phase. Contrary to average of present study Ayorinde (1994) and Singh (2013) reported that feed intake decrease significantly as the levels of dietary energy was increased.

Interaction means in the present study revealed that in the both housing i.e., battery brooder and deep litter when energy levels increased in the diet average feed intake g/bird/week increased marginally from D\textsubscript{1} to D\textsubscript{2} levels but increased at D\textsubscript{3} level.
Effect of housing and dietary energy on FCR (1-8th week of age):

On analysis of variance for FCR 1-8th week of age was slightly more efficient in H₂ (2.04±0.04) than H₁ (2.06±0.03). Difference was statistically not significant.

Over all effect of dietary energy on FCR per bird 1-8th week reveled in table 12 i.e. D₁ is having better FCR as compared to D₃ and D₂ however D₄ (2700 kcal/ME/kg + garlic) showed better of FCR 1.95 ±0.02 than D₂ (2700 kcal/ME/kg) 2.11±0003.

Dehury et al. (2008) reported that energy and protein interaction effect was not significantly different.

On the contrary the present study do not agree with the results of Dario et al. (2010) who reported significantly (P < 0.05) better FCR in normal energy normal protein (23.0: 2970), a trend also exhibited by protein efficiency ration (PER). The FCR in finisher phase was better for birds on moderate protein and high energy (20.14% C.P. and 2995 kcal ME/kg) but lowest for low energy high protein (22.17% C.P. and 2800 kcal ME/kg).

Similar to present study Gbenga et al. (2009), Rahmatnejad et al. (2009) concluded that FCR is not significantly affected by dietary treatments.

Conformation traits

Genetic improvement in a poultry population especially in meat type chicken depends on the utilization of magnitude of variability to attain better rate of growth. Alike body weight, conformation traits are important traits from economic reasons. The body measurement like breast angle, keel lenght and shank length have been found as an indication of skeletal size of birds. A significant association of shank length, body weight and keel length with eviscerated percent may prove useful for predicting the carcass yields.
**Housing Effect:**

Significantly higher breast angle was recorded in birds at 8th week in H₁ (51.4° ± 316) as compared to H₂ (48.8° ± 0.353) however similar were the finding for keel length (cm) and shank length (cm) in different housing system however means were statistically non significant.

Table 16 reveal the effect of dietary energy on conformation traits at 8th weeks of age. On statistical analysis D₃ (2900 kcal/ME/kg) showed significantly higher breast angle followed by D₂ (2700 kcal/ME/kg) and D₁ (2500 kcal/ME/kg) respectively.

However, D₄ (2700 + garlic) differed significantly with D₂ (2700 kcal ME/kg) for breast angle i.e 51.23° ± 0.33 and 49.20° ± 0.54 etc.

Similar were the finding reported for keel length and shank length at different dietary energy levels but statistically non significant.

The present results are in good agreement with Mahadik (1994) and Singh (2013) they concluded that energy effect was significant for 8th and 10th week for keel length. There results are not in good agreement for present study means value for keel length.

Shyamsunder et al. (1988) and Giri (2004) in a study involving two housing systems (deep litter and cages) executed non significant effect on conformation traits and are less important of conformation traits.

Similar to present experiment Atkare (2001) observed significant effect of energy levels on breast angle but present results are not similar for shank length.

**Carcass traits**

Carcass traits of commercial dual purpose colour birds were evaluated at 8th week of age.
Inedible parts

Analysis of variance for carcass for starved live body weight, % shrinkage loss, % blood less, % feather loss were non significant for housing system, dietary treatments and for housing x dietary level interaction effect. In housing system $H_1$ have heavier starved live weight than $H_2$ i.e., 949.23±17.7 and 928.91±13.67g.

Rao et al. (1996) reported similarly that dietary regime had significant effect on % blood loss.

Rajini et al. (1998) reported that both eviscerated carcass and ready to cooked yield was not affected by energy levels of diet.

Atkare (2001) reported non significant effect of energy level of carcass traits in both hot and cold climate.

Edible Parts:

Analysis of variance revealed non significant housing effect, dietary effect and housing x dietary interaction for % eviscerated yield, % giblet yield and % abdominal fat. Only dietary effect was significant for abdominal fat %.

Similar to present study, present results are not in agreement with those of Ramarao et al. (2005). They reported that the amount of fat deposition in abdominal area was significantly reduced by reducing dietary energy contents.

Singh (2013) concluded that energy effect was non significant for eviscerated yield but total meat yield percent was significant in male.

Rao et al. (1996) reported that the abdominal fat pad and giblet yield were least in different diets (20% C.P. and 2900 kcal/ME/kg) and was higher in severely restricted diet (18% C.P. and 2700 kcal/ME/kg diet).
On the contrary Raju et al. (1996) reported significantly high carcass yield and weight of abdominal fat with higher energy level (2900 kcal ME/kg) than the lower energy level (2600 and 2750 kcal ME/kg).

**Cutup parts yield:**

The effect of housing system on cutup parts showed non significant difference for most of cut-up part of male. The effect of dietary energy levels showed significant difference on breast % and show non significant difference on leg %, wing % and back with neck %. The mean value of D₁ (22.31±0.47%) differ significantly from D₃ and D₄ dietary energy levels i.e. D₃ (20.43%) and D₄ (24.49%) however more breast % was recorded in D₄ (24.49%). D₁ and D₂ dietary treatment means for TMY% were non significant. The effect of housing system on leg%, wing% and back with neck % show non significant difference.

Interaction effect due to housing system x dietary energy treatment were not significant for breast, leg, wing and back with neck %.

Mahmood et al. (2009) concluded that a basal feed containing 0.5% garlic failed to produce positive effects on carcass yield in term of dressing percentage, relative of weight of heart, gizzard, liver, spleen and pancreases.

Present study are similar to Ashayerizadhen et al. (2009) reported that garlic added in the broiler had non significant effect on breast weight and thigh weight whereas abdominal fat % decreased in garlic supplementated birds.

**Economics**

The housing system birds when average over 4 diets fetched income of Rs 16.17 in H₁ and H₂ housing system bird produced income of Rs 16.72. The two housing system average over different diet produced income over chick and feed cost 14.73, 16.11, 15.66 and 19.29 for D₁, D₂, D₃ and D₄ diets respectively. The highest income was produced by H₁D₄ diet followed by H₂D₂ diet.
Rajini et al. (1996) concluded a 2x2x2 factorial experiment involving two systems of rearing viz. cages Vs deep litter, two farm of feed mesh Vs pellet and without Vs with oil supplementation. They concluded that caged reared bird showed improve broiler farm economics index than those on deep litter. Higher income over feed cost was recorded in cage reared chicks. The feed cost/kg live weight (Rs) worked out to be high in floor reared birds Rs 16.07 and Rs. 18.74 for the 6th and 8th week of age respectively.

Singh (2013) concluded that significantly higher income over feed cost in $E_1$ energy was Rs 34.55. The lowest profit found in high protein-high energy diet with or without probiotic.
6. SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary

Indian poultry industry divided into commercial poultry farming and rural back yard poultry farming. In rural production without investment is the most potent attribute of dual purpose breeds which are raised in backyard since centuries in rural area. Dual type coloured commercial (25% Kadaknath: 75% Jabalpur colour) birds having better growth and egg production performance than indigenous birds.

There are evidence that garlic (*Allium sativum*) has cholesterol lowering effect due to the presence of sulphur-containing bioactive compound, several enzymes, amino acids and minerals and feeding result in better growth.

Two way analysis of variance with interaction design (Completely Randomized Design) was utilized in present study having 3 energy levels 2500, 2700 and 2900kcal ME/kg (D₁, D₂, D₃) with isonitrogenous diet and supplementation of garlic powder with 2700kcal ME/kg(D₄). The experimental population consists of randomly selected 160 day old commercial dual purpose coloured chicks. The chicks were distributed equally to two housing systems, H₁ chicks will be reared in battery brooder and H₂ group in the deep litter pens, as per replicate wise and treatment wise. Each treatment will be consisting of 2 replicates containing 10 chicks in each unit.

The present experiment was conducted upto 8th weeks of age. Chicks were of single hatch and experiment was of day old to 8th weeks of age. The data were recorded replicates wise on weekly basis such as body weight, feed intake, FCR and percentage mortality. Conformation traits and carcass traits measured at 8th week of age.
At 5\textsuperscript{th} week of age the chicks were significantly heavier in battery brooder their trends continued upto 8\textsuperscript{th} week of age though statistically non significant for day old, 4\textsuperscript{th}, 6\textsuperscript{th} and 8\textsuperscript{th} week of age.

Dietary effect showed significant difference at 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th}, 5\textsuperscript{th} and 7\textsuperscript{th} week. At seventh week of age D\textsubscript{3} and D\textsubscript{4} dietary group weighed more or less (776.80 and 759.63 g) respectively. Their body weight significantly differed than that of D\textsubscript{2} and D\textsubscript{1} diets. The results suggested that inclusion of dried garlic powder enhances the body weight.

Feed intake g/bird/week was mostly highly significant at 2\textsuperscript{nd} to 8\textsuperscript{th} week of age; the mean values of feed intake g/bird/week were higher in chicks kept in battery brooder than deep litter. Average total feed intake /bird (1\textsuperscript{st} to 8\textsuperscript{th} week of age) of chicks kept in battery brooder (H\textsubscript{1}) and deep litter (H\textsubscript{2}) was 1743.22±12.3 and 1680.68 g respectively. Chicks kept in deep litter housing system consumed significantly less than the battery brooder groups chicks.

Analysis of variance of body weight at different ages (day old – 8\textsuperscript{th} week of age) revealed mostly highly significantly difference due to 4 different diet levels, however body weight at day old, 6\textsuperscript{th} week and 8\textsuperscript{th} week age were non significant. At seventh week of age D\textsubscript{3} & D\textsubscript{4} dietary groups weighed more or less similar (776.80 and 759.63g) respectively. Their body weight significantly differed than that of D\textsubscript{2} and D\textsubscript{1} diets (726.88 and 720.25g). Similar trends were also observed for 8\textsuperscript{th} week though they were statistically non significant.

Overall effect of dietary energy on FCR/bird 1-8\textsuperscript{th} week revealed in table 12 i.e. D\textsubscript{1} is having better FCR as compared to D\textsubscript{3} and D\textsubscript{2} however D\textsubscript{4} (2700kcal ME/kg + garlic) show better FCR 1.95±0.02 than D\textsubscript{2} (2700 kcal ME/kg)2.11±0.03.

Among conformation traits mean due to different treatment effect were highly significant for housing, dietary treatment and interaction between them for breast angle only.
Analysis of variance for carcass starved live body weight (g), %shrinkage loss, %feather loss were non significant for housing × dietary energy interaction, but dietary energy show significant effect on starved live weight,

Analysis of variance for edible parts like eviscerated yield per cent, giblet per cent and total meat yield per cent were non significant for housing system, dietary treatments and their interaction. Only dietary effect was significant for abdominal fat.

The effect of housing system dietary energy treatments level and interaction on cut up part shows non significant difference for most of cut up part of male. The effect of dietary energy level showed significant difference on Breast percent
6.2 Conclusion

- Dietary effect significantly influenced body weight mostly from 1-7\textsuperscript{th} week of age, the average feed intake were highly significant from 1\textsuperscript{st} – 8\textsuperscript{th} week of age.
- Dietary treatments and interaction effect were highly significant for breast angle only. Carcass trait showed significantly effect due to dietary treatments for Breast weight and abdominal fat per cent.
- Inclusion of dried garlic powder (D\textsubscript{4}) significantly increased body weight reduced average total feed intake and improved feed efficiency and significantly reduced abdominal fat percent and increased breast angle and starved weight.
- The chicks housed in deep litter consumed significantly less feed. The housing does not affect most of the conformation traits.
- The highest income was produced by H\textsubscript{1}D\textsubscript{4} diet followed by H\textsubscript{2}D\textsubscript{4} diet higher energy levels increases the income over chick and feed cost.
6.3 Suggestions for Future Work

1. Commercial dual type colour bird (Kadaknath 25%: Jb col. 75%) need further feeding trials to evaluate its growth and production performance in intensive and backyard farming system on larger scale to reduce their production cost.

2. In rural farming system supplementation of various herbs including dried garlic powder which may help to enhance production performance of birds under harsh climatic condition, and may help to improve health status of birds, by enhancing their resistance without reducing egg and meat quality.
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