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NPY/*Dra*I polymorphism and their association with some reproductive traits of ac chickens from 16–67 weeks old

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ABSTRACT

The study was conducted at a chicken farm in Phong Dien District, Can Tho City, from May 2022 to July 2023, to assess the association between the NPY/DraI polymorphism and key reproductive parameters in Ac hens. A total of 400 hens were raised in cages according to the individual method at the age of 16–67 weeks. The results showed that NPY/DraI had a high association with average age of first egg laying, laying rate, the total number of eggs, feed intake/10 eggs and FCR ($P<0.05$). The Ac hens had the age of the first egg laying at 117 days old (II genotype), 119 days old (ID genotype) and 121 days old (DD genotype). In the period from 16 to 67 weeks old, Ac hens with II genotype had the highest egg production (149 eggs/hen/52 weeks of laying), laying rate (42.3%) and the lowest of average feed consumption/10 eggs (1.33 kg), FCR (3.54 g feed/g egg). These results indicated that hens with II genotype can be used in breeding Ac chickens for egg production.

1. INTRODUCTION

Poultry production plays a significant role in Viet Nam's agricultural sector, with the total poultry population reaching 544.5 million. Additionally, the country's poultry egg production increased from 16 billion eggs in 2020 to over 18.3 billion eggs in 2022, highlighting the sector's steady growth. (General Statistics Office of Vietnam, 2023). To meet consumers' demand for poultry eggs, Vietnam has imported, researched and put into production many commercial chicken breeds with high egg productivity such as Leghorn chickens, ISA Brown chickens, Hyline chickens, etc. These chicken lines have early sexual maturity (1–-20 weeks of age), no longer have brooding instincts, and had high egg production. However, consumers still like to eat domestic eggs and are willing to pay higher prices. Among domestic chicken breeds, the Ac chicken is characterized by its small body size, white scratchy feathers, and distinctive five-toed feet. Notably, its skin, flesh, bones, and beak are all black, making it a unique breed within Viet Nam's poultry sector.Ac chickens are commonly raised in the Mekong Delta and Southeastern provinces of Viet Nam and are traditionally valued for their medicinal properties, believed to promote health. However, research on the fertility of Ac chickens remains limited, highlighting the need for further studies in this area. The NPY gene located on chromosome 2, including 4 exons (sizes of exons 1, 2, 3 and 4 were 86, 188, 82 and 195 bp, respectively) and 3 introns (sizes of introns 1, 2 and 3 were 965; 4,300 and 2,300 bp, respectively) (Gene ID: 396464). NPY was a polypeptide with 36 amino acids, belonging to the family of polypeptides secreted by the pancreas (Tatemoto et al., 1982). NPY participated in neuroendocrine function, regulating heart rate, the reproductive system and gastrointestinal tract,

controlled body temperature and regulated the secretion of pituitary hormones. The NPY gene affected the release of GnRH in the hypothalamus, which had an important function in controlling feed intake in birds, impacting their reproductive activity and age of sexual maturity (Li et al., 2013). In Viet Nam, there are not many studies on gene polymorphisms and their association with reproductive performance traits on Ac chickens. Therefore, the present study was conducted to evaluate the association with the NPY/*Dra*I polymorphism to the reproductive traits on Ac chickens at 16-67 weeks old.

2. MATERIALS AND METHODS

2.1. Experimental animal

The present study was carried out at a local chicken farm in Phong Dien district, Can Tho city, from May 2022 to July 2023. From 16 to 67 weeks old, Ac hens were kept individually in a cage (cages dimensions: width 25 cm, length 40 cm, height 35 cm) (Figure 1), feeding the diets consisting of 17% crude protein and 2,850 kcal/kg metabolisable energy (Table 1), and a 16 hours/day lighting regime. The hens had *ad libitum* access to feed and water throughout the experiment. All experimental chickens were vaccinated and treated according to the procedures of Emivest Feedmill Viet Nam.

Table 1. Chemical composition of diet

Chemical composition	Content
Dry matter (%)	87.0
Crude protein (%)	17.0
Metabolisable energy (kcal/kg)	2,850
Crude fiber (%)	5.00
Calcium (%)	3.50
Phosphorus (%)	0.85
Ash (%)	20.0

Figure 1. Ac hens at 15 weeks old

The reproductive traits were followed during the study period, including: average age at first egg laying, body weight at sexual maturity, total number of eggs, egg production rate, eggs weight, eggs shape index (the ratio of small diameter/large diameter), feed intake/10 eggs and feed conversion ratio (FCR) (Table 3).

2.2. Methods

*** DNA extraction and genotyping**

Chicken feather samples from each individual were collected, preserved in plastic bags and stored at -20ºC. Using the method of Bello et al. (2001) for DNA extraction. Besides, using specific primer pairs for the NPY/*Dra*I polymorphism based on previous research by Xu et al. (2011a) (Forward: 5'-TCTCAGAGCTCCAACGTATGA-3', reverse: 5'-ATATTTCTGTGCCTGAACAACA-3').

The PCR was performed in a 50 µl reaction consisting of 12 µl MyTaq Buffer 5X, 1 µl MyTaq DNA Polymerase (5 unit) (Bioline, Meridian Bioscience), 1 µl each primer (20 µM), 4 µl genomic DNA (50 ng/µl) and 33 µl PCR water. The PCR thermal cycler was carried out with the following conditions: denaturation (95ºC for 5 min), 35 cycles of 95ºC for 30 seconds, annealing 59ºC for 30 seconds, extension 72ºC for 45 seconds and final extension 72ºC for 10 minutes. The PCR product of each gene was incubated with the *Dra*I restriction enzyme (Thermo Fisher Scientific™) overnight at 37°C. The final products of each gene were separated on 3.5% agarose gel for 45 minutes at 80V for identifying genotypes. Besides, the polymorphic site was also recognized by sequencing with Sanger's method.

*** Determine the association between NPY/*Dra*I polymorphism and reproductive performance of Ac hens**

After determining the genotype, hens raised in cages to collect reproductive parameters for the purpose of investigating the association between the NPY/*Dra*I polymorphism and reproductive performance. The experiment was arranged completely randomly with three treatments as follows:

- Treatment 1: 87 hens with DD genotype.
- Treatment 2: 183 hens with ID genotype.
- Treatment 3: 130 hens with II genotype.

*** Recorded data:** reproductive parameters based on research of Doan et al. (2011). Each hen was noted the age at first egg and body weight at first egg. Eggs were collected at 5 p.m each day, and each egg was marked to track individual performance.

– Egg shape index (%) = (small diameter, mm)/(large diameter, mm) x 100

– The average age at first egg (days old): record the age of each individual at first egg.

– Body weight at first egg (kg): record the hen's body weight at first egg.

– Total eggs from 16-67 weeks old (egg/hen/52 laying weeks): record the number of eggs per day for each individual.

– Laying rate (%) = (Total egg of each individual per week)/7 x 100

– Feed intake/10 eggs (Kg): (Total feed intake each individual/Total egg of each individual) x 10

– FCR (g feed/g egg): Total feed intake each individual/Total egg weight of each individual

2.3. Statistical analyzes

The data was recorded using Excel software. The association between generations and productive traits was analyzed based on ANOVA – One-way Analysis of Variance of Minitab software version 16.0. Data are presented as Least square mean ± Standard deviation. Allelic and genotypic frequencies were calculated by POPGENE version 13.0. A high P value can result in an extremely large output when having a large number of alleles/locus, loci and populations. In most cases, $P<0.05$ should be used.

3. RESULTS AND DISCUSS

3.1. Allelic and genotypic frequencies of NPY/*Dra*I in Ac chicken population

The PCR products of NPY/*Dra*I polymorphisms were determined by PCR-RFLP method with specific primer pairs and *Dra*I restriction enzyme. Electrophoresis results on a 3.5% agarose gel indicated there were two alleles (D and I alleles) corresponding to three genotypes DD, ID and II. Figure 2 presented the II genotype had one band on agarose gel with a size of 248 bp, the ID genotype obtained three bands with sizes of 81 bp, 167 bp and 248 bp; and the DD genotype had two bands with sizes of 81 bp and 167 bp.

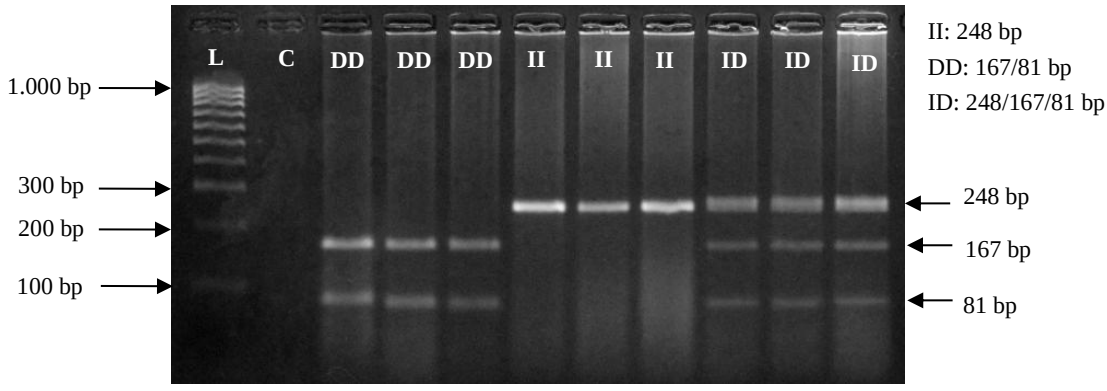

Figure 2. Presentation of PCR products of NPY/*Dra*I on 3.5% agarose gel electrophoresis

Lane L: DNA marker (100-1,000 bp); lane C: negative control; lane 3, 4, 5: DD genotype; lane 6, 7, 8: II genotype; lane 9, 10, 11: ID genotype

The DNA sequencing results indicated that NPY/*Dra*I polymorphism was an Indel with 4 bp TATT (forward strand) inserted into I allele (Figure 3) and AATA (reverse strand) in I allele (Figure 4). This result was similar to previous publications by Li et al. (2009) and Xu et al. (2011b) on native chicken Ningdu Shanghuang (China) that also showed two I and D alleles corresponding to three genotypes II, ID and DD on this polymorphism. In Viet Nam, the result of Ngu et al. (2015) in Noi chickens also showed the I and D alleles corresponding to II, ID and DD genotypes. In addition, the research results of Li et al. (2009) on Wenchang chickens also confirmed NPY/*Dra*I polymorphism with A allele (240 bp) and a allele (161 bp and 79 bp) corresponding to AA, Aa and aa genotypes, respectively. Although the amplified DNA fragment size was different from the present study, the NPY/*Dra*I polymorphism position was similar in the above results.

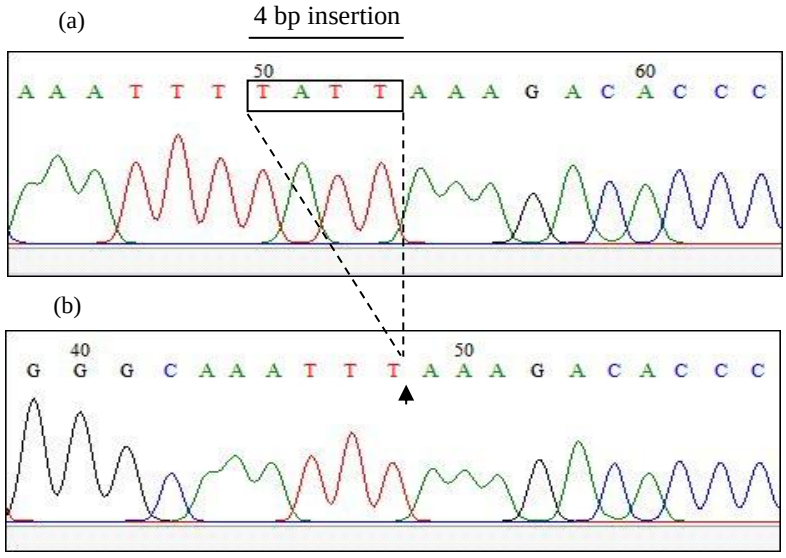

Figure 3. The nucleotide sequence of a DNA fragment (forward strand) on NPY gene

(a) I allele; (b) D allele

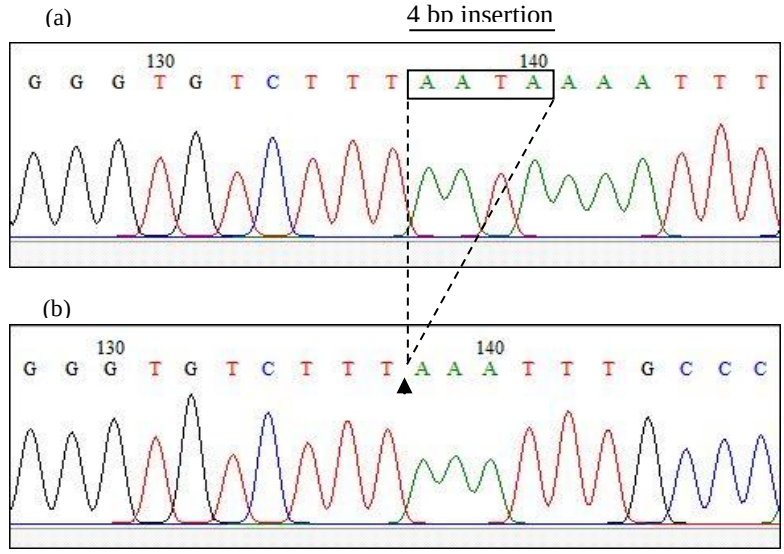

Figure 4. The nucleotide sequence of a DNA fragment (reverse strand) on NPY gene

(a) I allele; (b) D allele

Evaluating the allelic and genotypic frequencies of a gene is an important step in the process of breeding research. This result provides genetic diversity among individuals in a population. Besides, the combination of gene polymorphisms with phenotypes that helps to select many individuals with the desired genotype or phenotype.

Table 2. The allelic and genotypic frequencies of NPY/*Dra*I locus in Ac hens population (n = 400)

Polymorphism	Observed					Expectated			P
	Genotypes			Alleles		Genotypes			
	DD	ID	II	D	I	DD	ID	II	
NPY/*Dra*I	0.22 (87)	0.46 (183)	0.32 (130)	0.45	0.55	0.20 (80)	0.49 (198)	0.31 (122)	0.137

Table 2 presented the D allelic frequency (0.45) was lower than I allele (0.55). This result was similar to the study of Fatemi et al. (2012) that B allele frequency (0.78) (corresponding to allele I) was higher than b allele (0.22) (corresponding to allele D) in the Mazandaran indigenous chicken (Iran). In contrast, a allelic frequency (0.54) was higher than A allele (0.46) in Chinese native chickens (Li et al., 2009) and Azarbaijan native chickens (Iran) had a higher a allelic frequency (0.76) than A allele (0.24) (Abdi et al., 2014). The allelic frequencies were different among the investigated gene polymorphisms, and the cause may be due to different factors affecting the population such as mutation, genetic drift or selective pressure to improve reproductive performance, leading to increased genotype frequencies of individuals with high egg productivity in the population (Masel, 2012).

Besides, allele D frequency (0.45) and allele I frequency (0.55) so the expected genotype frequency in the population according to the Hardy-Weinberg law was DD (0.20), ID (0.49), II (0.31). This result represented a statistically insignificant difference with the observed genotype frequency (P>0.05). This proved that the NPY/*Dra*I polymorphism obeyed the Hardy-Weinberg law. This proved that the Ac hens were selected randomly from a population with a relatively large number of individuals, and the population was not affected by genetic drift and selection.

3.2. The association between the NPY/DraI polymorphism and some reproductive traits on Ac hens

Table 3 showed the genotypes of the NPY/*Dra*I polymorphism had statistically significant differences in parameters related to reproductive performance of Ac hens from 16 to 67 weeks old (P<0.05). The average age of the first egg laying in hens with II genotype (117 days old) was earlier than ID genotypes (119 days old) and DD genotypes (121 days old). This result indicated that II genotype had the earliest age of sexual maturity and this was of great significance for bringing economic efficiency in egg production.

The association between NPY/*Dra*I polymorphism and age at first egg laying was also found by Dunn et al. (2004) on 772 broiler chickens with age at first egg laying ranging from 189.4-193.8 days (193.8 days old in +/+ *Dra*I genotype; 198.0 days old in +/- *Dra*I genotype and 189.4 days old in -/- *Dra*I genotype). In addition, Vu and Ngu (2016) also confirmed the NPY/*Dra*I polymorphism on Noi chickens that was closely related to the age at the first egg laying (190.5 days old in II genotype; 178.5 days old in DD genotypes and 178.0 days old in ID genotype).

The average age of laying the first egg of Ac hens in the current study was earlier than some other domestic chicken breeds such as Lien Minh chickens (186-187 days old in VIPR1/*Hha*I polymorphism and 178-189 days old in VIPR1/*Taq*I polymorphism) (Nguyen et al., 2018) and Noi chickens (161-168 days old) (Hoa et al., 2021). The first egg-laying age of Ri chickens was 133 days old; the chicken flock reaches a 5% laying rate at 147 days old and the peak at 217 days old (Thinh et al., 2021b). Lac Thuy chickens lay early, with a laying age rate of 5% at 137 days old and a peak laying age of 196 days old (Thinh et al., 2021a). Thus, Ac hens in this study had an earlier age of sexual maturity than some native chicken breeds raised in Viet Nam.

Table 3. Association of NPY/*Dra*I polymorphism with reproductive traits in Ac hens at 16-67 weeks old (52 laying weeks)

Iterms	Genotypes			P
	DD (n = 87)	ID (n = 183)	II (n = 130)	
AFE (day)	121±4.16[a]	119±5.65[b]	117±5.33[c]	0.001
BWFE (g)	733±31.3	731±42.2	732±33.9	0.869
Egg weight (g)	36.2±0.66[a]	35.8±0.83[b]	36.2±1.01[a]	0.001
Egg shape (%)	77.4±0.43[a]	77.3±0.28[a]	77.1±0.47[b]	0.001
Total eggs (eggs/52 laying weeks)	124±15.2[c]	132±25.2[b]	149±12.8[a]	0.001
Laying rate (%)	35.6±4.02[c]	37.5±6.64[b]	42.3±3.03[a]	0.001
FCR (g feed/g egg)	4.25±0.55[a]	4.17±0.83[a]	3.54±0.24[b]	0.001
Feed intake for 10 eggs (kg)	1.61±0.22[a]	1.56±0.34[a]	1.33±0.11[b]	0.001

AFE: Age at first egg; BWFE: Body weight at first egg

[a,b]: Means with different letters in the same row differ significantly (p<0.005)

The egg weight of Ac hens with NPY/*Dra*I polymorphism ranges from 35.8-36.2 g/egg. This result was equivalent to the study of Lan et al. (2018) in Ac hen eggs (33.4-37.2 g/egg) at 16-23 weeks old. The egg shape index of the NPY/*Dra*I polymorphism ranges from 77.1-77.4%. The body weight at the first egg with DD genotype (733 g/bird) was heavier than II genotype (732 g/bird) and ID genotype (731 g/bird). Cheung et al. (1997) suggested that NPY gene stimulateed early sexual development in chickens and controlled feed absorption. The NPY gene influenced the release of gonadotropin hormone (GnRH) and played an important role in controlling feed intake in birds, forming sexual characteristics and controlling ovulation. The effect of the NPY gene on the body weight of hens may be due to its role in controlling feed intake and growth hormone secretion (Dunn et al., 2004; Wu et al., 2007).

Besides, hens with II genotype (149 eggs/hen/52 weeks of laying) had higher egg yield than ID genotype (132 eggs/hen/52 weeks of laying) and DD genotype (124 eggs/hen/52 weeks of laying). High egg productivity in II genotype resulted a higher laying rate (42.3%) compared to ID genotype (37.5%) and DD genotype (35.6%). The results of Li et al. (2009) on Wenchang native chickens (China) indicated the NPY/*Dra*I polymorphism affected egg productivity up to 300 days old, in which hens with AA genotype (corresponding to II genotype in the present study) had the highest egg number (88.9 eggs/hen/300 days old) and the aa genotype was the lowest egg production (81.6 eggs/hen/300 days old). The egg productivity of II genotype in this study was higher than Bang Troi hens at 37-40 weeks old (34.1%) (Thinh et al., 2020). According to Hoa et al. (2021), the egg production of Noi black chickens was 74.3 eggs/hen and Noi dark brown chickens was 77.9 eggs/hen from 25 to 50 weeks old. The total eggs of Ho chicken and Dong Tao chicken were 88.5 eggs/hen and 94.9 eggs/hen, respectively (Duy et al., 2020). In addition, Noi chickens with DD genotype (NPY/*Dra*I) was 50.9 eggs/hen/20 laying weeks (Ngu et al., 2015). These results showed that NPY/*Dra*I polymorphism was a potential molecular marker to improve egg productivity in Ac chickens.

Besides, the average daily feed intake of hens with DD, ID and II genotypes were the same (54.0 g/hen/day). Hens with II genotype had the lowest feed consumption/10 eggs (1.33 kg) and FCR (3.54 g feed/g egg) compared to the others. This result showed that II genotype (NPY/*Dra*I polymorphism) can be of interest because of its feed consumption/10 eggs and low FCR, contributing to increasing the economic efficiency of livestock production in the direction of egg production.

3.3. Laying rate, egg production and feed intake/10 eggs

Table 4 and Figure 5 showed that the laying rate of Ac hens was low (0.0-2.09%) at 16 weeks old but gradually increased in the following weeks, reached a peak (52.9-60.0%) at 30 weeks old and then gradually decreased. At 30 weeks old, hens with II genotype had a higher laying rate (60.0%) than ID genotype (55.5%) and DD genotype (52.9%). The laying rate of Ac hens in the current study was high compared to some other domestic chicken breeds, such as Ri chicken, at 38 weeks old (39.9%) (Mui and Dang, 2016); Lac Thuy chicken at 40 weeks old (33.6%) (Van et al., 2015); Bang Troi chicken at 37 to 40 weeks old (34.1%) (Thinh et al., 2021a); Ri Lac Son chicken at 40 weeks old (31.4%) (Thinh et al., 2021b).

Table 4. Laying rate (%), egg production and feed intake/10 eggs of Ac hens during 16-67 weeks old

Weeks old	Laying rate (%)			Egg number (eggs/hen/week)			Cumulative total egg number (eggs/hen)			Feed intake/10 eggs (kg)		
	DD	ID	II	DD	ID	II	DD	ID	II	DD	ID	II
16	0.00	1.64	2.09	0.00	0.11	0.15	0.00	0.11	0.15	-	29.5	23.2
17	4.27	5.78	7.80	0.30	0.40	0.55	0.30	0.52	0.69	11.6	8.54	6.32
18	15.1	12.9	13.1	1.06	0.90	0.92	1.36	1.42	1.61	3.35	3.88	3.83
19	19.7	16.1	19.6	1.38	1.13	1.37	2.74	2.55	2.98	2.61	3.18	2.61
20	25.0	24.7	25.9	1.75	1.73	1.82	4.48	4.28	4.79	2.10	2.10	2.01
21	27.1	28.6	29.9	1.90	2.01	2.09	6.38	6.28	6.88	1.97	1.85	1.77
22	29.1	30.8	32.5	2.03	2.16	2.28	8.41	8.44	9.16	1.88	1.76	1.68
23	31.9	34.1	35.6	2.23	2.39	2.49	10.6	10.8	11.7	1.71	1.60	1.53
24	34.6	36.5	40.1	2.43	2.55	2.81	13.1	13.4	14.5	1.57	1.49	1.36
25	38.6	40.3	46.3	2.70	2.82	3.24	15.8	16.2	17.7	1.41	1.35	1.18

Weeks old	Laying rate (%)			Egg number (eggs/hen/week)			Cumulative total egg number (eggs/hen)			Feed intake/10 eggs (kg)		
	DD	ID	II	DD	ID	II	DD	ID	II	DD	ID	II
26	43.2	45.1	52.5	3.02	3.16	3.68	18.8	19.4	21.4	1.26	1.21	1.04
27	49.3	50.5	56.2	3.45	3.54	3.93	22.2	22.9	25.3	1.11	1.08	0.97
28	51.1	53.6	57.9	3.57	3.75	4.05	25.8	26.7	29.4	1.07	1.01	0.94
29	51.9	55.2	59.8	3.63	3.86	4.18	29.4	30.5	33.5	1.05	0.99	0.91
30	52.9	55.5	60.0	3.70	3.89	4.20	33.1	34.4	37.7	1.02	0.98	0.91
31	52.1	52.5	59.0	3.64	3.67	4.13	36.8	38.1	41.9	1.05	1.04	0.92
32	50.6	49.0	57.0	3.54	3.43	3.99	40.3	41.5	45.9	1.08	1.11	0.95
33	46.3	46.6	56.7	3.24	3.26	3.97	43.6	44.8	49.8	1.17	1.17	0.96
34	44.7	45.4	55.5	3.13	3.18	3.88	46.7	47.9	53.7	1.22	1.20	0.98
35	44.0	46.1	55.2	3.08	3.23	3.87	49.8	51.2	57.6	1.23	1.18	0.98
36	44.7	46.8	54.2	3.13	3.27	3.79	52.9	54.4	61.4	1.22	1.16	1.00
37	42.5	43.9	53.4	2.98	3.07	3.74	55.9	57.5	65.1	1.28	1.24	1.02
38	41.9	44.7	53.0	2.93	3.13	3.71	58.8	60.7	68.8	1.30	1.22	1.02
39	41.9	43.8	52.2	2.93	3.07	3.66	61.7	63.7	72.5	1.30	1.24	1.04
40	39.9	44.1	51.2	2.79	3.09	3.58	64.5	66.8	76.1	1.36	1.23	1.06
41	40.9	41.9	50.8	2.86	2.93	3.56	67.4	69.7	79.6	1.33	1.30	1.07
42	37.9	43.5	50.0	2.66	3.04	3.50	70.1	72.8	83.1	1.43	1.25	1.09
43	39.6	43.1	48.6	2.77	3.02	3.40	72.8	75.8	86.5	1.38	1.26	1.12
44	38.3	40.9	46.4	2.68	2.86	3.25	75.5	78.7	89.8	1.42	1.33	1.17
45	36.8	42.5	47.1	2.57	2.97	3.30	78.1	81.6	93.1	1.48	1.28	1.15
46	36.5	40.7	46.4	2.55	2.85	3.25	80.6	84.5	96.3	1.50	1.34	1.17
47	35.6	38.9	44.3	2.49	2.72	3.10	83.1	87.2	99.4	1.53	1.40	1.23
48	34.2	39.6	43.6	2.39	2.77	3.05	85.5	90.0	102.5	1.59	1.37	1.25
49	34.6	38.4	42.9	2.43	2.69	3.00	87.9	92.7	105.5	1.57	1.42	1.27
50	33.8	38.3	43.6	2.37	2.68	3.05	90.3	95.3	108.5	1.61	1.42	1.25
51	32.0	37.2	42.9	2.24	2.61	3.00	92.6	97.9	111.5	1.70	1.46	1.27
52	32.7	34.9	41.4	2.29	2.44	2.90	94.8	100.4	114.4	1.67	1.56	1.32
53	31.9	35.8	40.0	2.23	2.50	2.80	97.1	102.9	117.2	1.71	1.52	1.36
54	30.9	34.0	40.7	2.16	2.38	2.85	99.2	105.3	120.1	1.77	1.60	1.34
55	30.4	31.1	38.6	2.13	2.18	2.70	101.4	107.4	122.8	1.80	1.75	1.41
56	29.4	33.1	37.9	2.06	2.32	2.65	103.4	109.8	125.4	1.84	1.64	1.44
57	27.4	31.7	37.1	1.92	2.22	2.60	105.3	112.0	128.0	1.98	1.72	1.47
58	29.1	30.3	35.7	2.03	2.12	2.50	107.4	114.1	130.5	1.88	1.80	1.52
59	26.9	30.9	35.0	1.89	2.16	2.45	109.3	116.3	133.0	2.02	1.76	1.55
60	28.4	29.2	35.7	1.99	2.04	2.50	111.2	118.3	135.5	1.91	1.87	1.53
61	28.1	30.2	34.3	1.97	2.11	2.40	113.2	120.4	137.9	1.94	1.80	1.58
62	26.4	28.9	32.9	1.85	2.02	2.30	115.1	122.4	140.2	2.06	1.88	1.66
63	26.6	27.0	31.4	1.86	1.89	2.20	116.9	124.3	142.4	2.05	2.01	1.73
64	25.1	27.8	25.7	1.76	1.95	1.80	118.7	126.3	144.2	2.17	1.96	2.12
65	26.4	26.2	24.3	1.85	1.83	1.70	120.5	128.1	145.9	2.06	2.08	2.24
66	25.0	24.9	22.9	1.75	1.74	1.60	122.3	129.9	147.5	2.17	2.18	2.38
67	24.3	24.6	22.9	1.70	1.72	1.60	124.0	131.6	149.1	2.24	2.21	2.38
Average	35.6	37.5	42.3	-	-	-	-	-	-	1.61	1.56	1.33

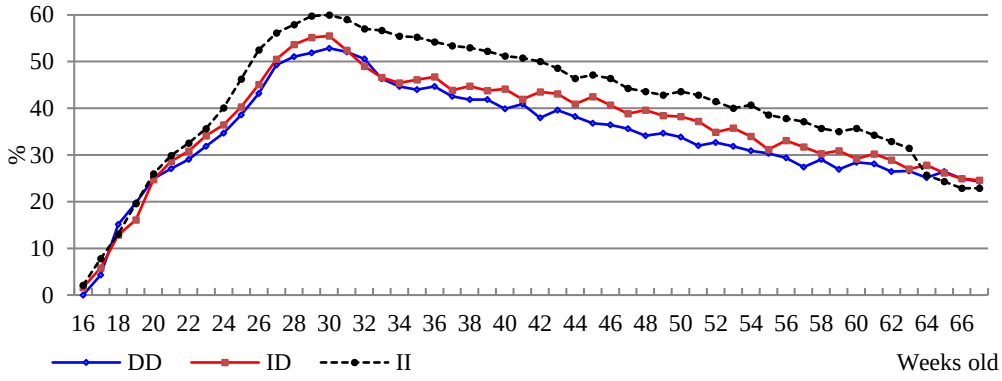

Figure 5. Laying rate on Ac hens at 16-67 weeks old

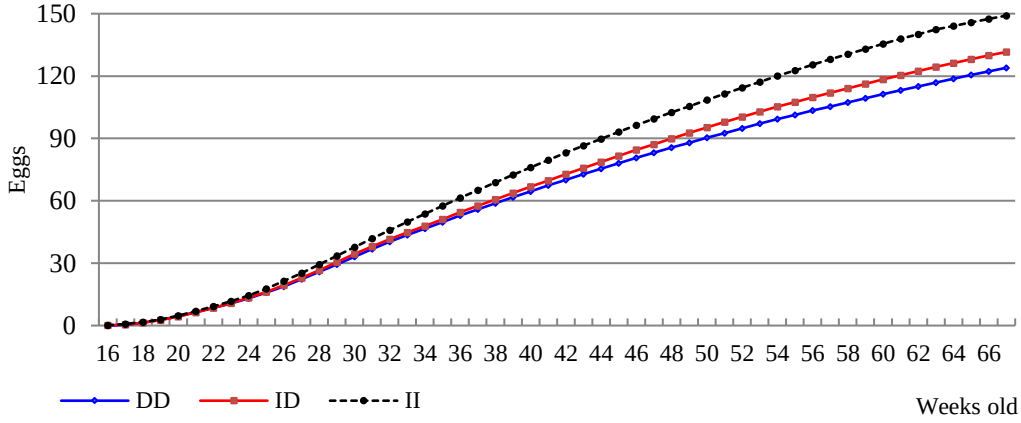

Figure 6. Cumulative total egg number on Ac hens at 16-67 weeks old

Table 4 and Figure 6 showed that cumulative total egg number of hens with II genotype (149 eggs/hen/52 weeks of laying) was the highest among the three hen groups. This result was higher than the egg yield of hens with II genotype (50.9 eggs/hen/52 laying weeks) in the study of Ngu et al. (2015). The results of Thinh et al. (2021) on Lac Thuy chickens showed the total accumulated eggs at 40 weeks old was 57.6 eggs/hen.

Besides, the feed consumption/10 eggs of Ac chickens at 16 weeks old was high (ID and II genotypes were 29.5 kg and 23.1 kg, respectively). The reason was that the chicken flock had just started laying in the early stages, so the laying rate was still low. The time to consume the least feed was at 30 weeks old (DD, ID and II genotypes were 1.02 kg, 0.98 kg and 0.91 kg, respectively) because during this period the chickens were at peak laying. The average feed consumption/10 eggs of Ac chickens from 16 to 67 weeks old was 1.61 kg (DD genotype), 1.56 kg (ID genotype) and 1.61 kg (II genotype). In Lac Thuy chicken, feed consumption/10 eggs from 19 to 41 weeks old was 4.49 kg (Thinh et al., 2021a), Ri Lac Son chicken at 20-40 weeks old was 4.0 kg (Thinh et al., 2021b), in Lac Thuy chickens at 20-40 weeks old was 3.44 kg (Van et al., 2015).

4. CONCLUSIONS

Hens with II genotype of NPY/*Dra*I polymorphism raised in individual cages had the average age of first egg laying of 117 days old. During the period of 16-67 weeks of old, Ac hens with II genotype had 149 eggs/hen/52 weeks of laying, an average laying rate of 42.3%, and feed intake/10 eggs of 1.33 kg and FCR 3.54 (g feed/g egg). These results showed that hens with II genotype of *Dra*I polymorphism can be used in breeding Ac hens for the purpose of egg production.

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