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Somatic cell count and an Animal Needs Index to evaluate animal welfare in dairy cattle on farms constructed to the standards of the Agriculture and Rural Development Support Institution

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Abstract

In this research, welfare measurements were made on 14 modern dairy cattle farms (Type 1) with similar enterprise scales and built without any support from any institution, and on eight modern dairy cattle farms (Type 2), which were built with the support of the Agriculture and Rural Development Support Institution (ARDSI), in the province of Konya, Turkey. Welfare levels of dairy cattle farms were measured using the Animal Needs Index (ANI) 35L/2000 method. Milk samples were taken from each of these enterprises and somatic cell counts were obtained. Collected data and calculated ANI scores were compared. While there was a substantial difference between the two enterprise types in terms of the scores obtained for stockmanship (welfare measurement) and the general ANI scores, there was no relationship between the enterprise types in terms of somatic cell count. According to the ANI 35L/2000 welfare measurement method, suitable welfare conditions were provided in these enterprises. However, when examining categories that determine the overall ANI welfare score, deficiencies in some welfare criteria such as flooring, stockmanship, and light–air conditions were noted.

Keywords: ANI 35L/2000, animal welfare, somatic cell count, dairy farm, Agriculture and Rural Development Support Institution
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Introduction

The rapid increase in the population worldwide has increased the demand for animal products, which are a high quality food source (Dinler, 2011). In order to meet this demand, intensive animal production systems have become widespread. In order to obtain high yields from the animals, the care and feeding of the animals, which are separated from their natural living conditions, are carried out in such modern shelter systems. However, the expected high level of efficiency in intensive production cannot be realized due to some problems related to welfare (Harrison, 1964).

Many new methods and technologies are used in dairy cattle barns to evaluate welfare and to determine the conditions that cause poor welfare conditions. It is reported that it can be important for businesses to eliminate these deficiencies and increase their profitability by providing more suitable conditions for animals (Garip *et al.,* 2022). Many methods have been developed for the evaluation of enterprises in terms of animal welfare. In addition, many incentive programs have been implemented to ensure welfare. In order to support the agricultural sector, the European Union has established the Instrument for PreAccession Assistance (IPA) within the scope of the Council Regulation No 1085/2006 for the candidate countries to further develop and improve their existing systems and to ensure animal welfare. For this purpose, the Agriculture and Rural Development Support Institution (ARDSI) has implemented Instrument for Pre-Accession Assistance Rural Development (IPARD) supports in order to raise the standards of livestock enterprises and bring them to EU levels. ARDSI provides guidance

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on some important technical and design issues as well as EU criteria for the enterprises it will support. Thus, the cattle barns are encouraged to attain a certain standard (TKDK, 2021). To evaluate animal welfare correctly, it is necessary to use methods that can be used easily and effectively in enterprises, that do not take much time, and that can measure many parameters related to welfare at the same time. In this context, the ANI 35L/2000 method developed by Bartussek *et al.* (2000) is a very effective method for the measurement of welfare.

In this study, animal welfare was measured using the ANI 35L/2000 method in dairy cattle enterprises supported by fulfilling the criteria set by ARDSI and in modern dairy cattle enterprises not governed by such regulations. Milk samples were taken from each farm to determine somatic cell count (SCC). The SCC data and animal welfare measurements were compared statistically.

Materials and Methods

This study was based on the PhD Thesis of Hasan KESKİN and was approved from the Ethics Committee of the Experimental Animal Production and Research Centre of Selcuk University, Faculty of Veterinary Medicine (SÜVDAMEK), with the decision number 2020/48 (11.06.2020).

SCC measurements of the milk samples collected from the enterprises were carried out using a FOSS brand milk analyser (FOSS Fossomatic™ FC, Denmark). A total of 22 modern, closed system dairy farms with similar milking capacities in the Konya region of Turkey were randomly selected and visited. Evaluated enterprises were grouped under two classes: Type 1 enterprises (n = 14), enterprises built without support from ARDSI or any institution; and Type 2 enterprises (n = 8), enterprises built with the support of ARDSI. The welfare measurements of the enterprises were made using the ANI 35L/2000-CATTLE method developed by Bartussek e*t al.* (2000). In order to evaluate animal welfare using the ANI Score, enterprises were given points under five categories:

1. Affording movement and locomotion (Locomotion)
2. Affording social interaction (Social interaction)
3. Type and condition of flooring (Flooring)
4. Light and air conditions (Light and Air)
5. Stockmanship (Stockmanship)

These five categories were also divided into sub-criteria, and points were given to each of these criteria as a result of the examinations made in the enterprises. By adding the scores obtained from all the criteria, the general ANI scores of the enterprises were determined and the welfare evaluations were made in the enterprises according to these scores. The ANI score can range from -9.0 to +45.5. Higher scores indicate better welfare. For animal welfare assessments, when the score was >28, it was expressed as very good; 24–28, good; 21–24 quite good; 11–16, borderline; and <11, bad (Bartussek, 2001). It is used as a practical method. On average, the implementation time of the welfare assessment with ANI in an enterprise was 44 minutes, with a variation of 30–90 min.

The content of ANI consists of seven forms to be filled in by the evaluator during the farm visit. Forms 1–5 are for the five assessment categories (Locomotion, Social interaction, Flooring, Light and air, Stockmanship), Form 6 is a summary page for calculating the overall ANI score, and Form 7 is a summary description of the farm (Bartussek *et al.,* 2000). Table 1 shows the categories used to calculate the ANI score and the criteria scored in these categories. The Student's *t*-test was used to compare the ANI scores obtained, and Fisher's exact Chi-square test was used to determine the relationship between SCC and the enterprise groups. Analyses were carried out using the SPSS 23.00 Windows 10 package program of IBM company.

Table 1 General Animal Needs Index using the ANI 35L/2000-CATTLE method developed by Bartussek e*t al.* (2000)

categories	a	b	c	d	e	f	g	Total
LOCOMOTION	loose/group housing		tether systems		outdoor exercise days/year	Pasture days/year		
	floor area	lying down, rising	cubicle/ stall size	movement of tether				
SOCIAL INTERACTION	floor area	herd structure	young	outdoor exercise days/year days/year	Pasture days/year			
FLOORING	lying area			Activity areas	outdoor yard	pasture		
	softness	cleanliness	slipperiness					
LIGHT & AIR	light	air quality	draught	noise	outdoor			
					outdoor exercise	outdoor hours/day		
STOCKMANSHIP	cleanliness	condition of equipment	condition of integument	cleanliness of animals	condition of hooves	technopathies	health	
TOTAL ANI SCORE								

Results

Another issue that was considered in the selection of the enterprises (Type 1, Type 2) selected in various districts and different enterprises in Konya province, was the size of the enterprise. There was a minimum of 101 and a maximum of 1 354 cattle in the enterprises included in the evaluation. The minimum number of dairy cows in the barns where welfare measurement was made was 32; the number of cows in the barn with the highest number of dairy cows was 180. When the number of dairy cows in the barns and the total number of animals in the enterprises were examined, average number of animals in Type 1, Type 2, and overall enterprises were calculated as 92.35-473.21, 67.5–186.75, and 83.31–369.04, respectively. When the establishment dates of the enterprises were examined, the average age of the enterprises included in the study was found to be 11.72 y, Type 1 enterprises were 11.92 y, Type 2 enterprises were 11.37 y.

The welfare level of 77.3% of the evaluated enterprises was very good, 13.6% were good, 4.5% were fairly good, and 4.5% were barely suitable. There were no enterprises of low or no suitability evaluated. When the average scores obtained in Type 1 and Type 2 enterprise groups in the study were examined, average scores of Type 2 enterprises receiving ARDSI support were higher than the average scores of Type 1 enterprises in all welfare measurement categories. The minimum and maximum values of the ANI are given under category headings for a better understanding of the subject (Table 2). The ANI averages of the enterprises were calculated as 28.96, 34.87, and 31.11 for Type 1, Type 2, and overall enterprises, respectively. These mean scores indicate that the enterprise types have “very good” welfare conditions (Table 2). The scores given to the welfare categories in the enterprise types and the total ANI scores are shown in Table 3. No significant differences were found between the enterprise types in terms of the scores obtained in the categories of locomotion, social interaction, light and air (P >0.05). There was a difference between the two enterprise types in terms of the scores obtained for stockmanship, flooring, and ANI score (P <0.05).

Table 2 Scores from welfare measurement categories and total Animal Needs Index (ANI) scores

No.	Enterprise Type	Locomotion (0–10,5)	Social Interaction (-1–10)	Flooring (-2,5–8)	Light & Air (-2–9,5)	Stockmanship (-3,5–8)	ANI Score (-9–46)	SCC (1000 units/mL)	Herd Size (head)	Average Milk Yield (L)
1	**Type 1**	9	7	4	9	5	34	242	228	25
2	**Type 1**	5,5	4,5	4,5	3,5	6,5	24,5	438	191	36
3	**Type 1**	3	4,5	0,5	4,5	0	12,5	1210	348	18
4	**Type 1**	8	7	3	4,5	3,5	26	358	235	19
5	**Type 1**	9	7	5,5	9	6	36,5	325	275	26
6	**Type 1**	9,5	7,5	3,5	9	3	32,5	914	183	15
7	**Type 1**	9	7	3	5,5	5	29,5	652	250	26
8	**Type 1**	6	7	0	8,5	1,5	23	493	175	22
9	**Type 1**	8	7	3	6	4,5	28,5	414	248	22
10	**Type 1**	8	6,5	4	5	5,5	29	396	788	31
11	**Type 1**	8,5	6,5	4,5	6,5	4,5	30,5	191	1122	38,5
12	**Type 1**	8,5	7	4	6	7	32,5	382	723	24
13	**Type 1**	9	7	5	7	5	33	141	505	30
14	**Type 1**	8,5	6,5	4	8	6,5	33,5	144	1354	30
Type 1 Enterprises (n: 14)	**Minimum**	3	4,5	0	3,5	0	12,5	141	175	15
	Maximum	9,5	7,5	5,5	9	7	36,5	1210	1354	38,5
	Mean	7,82	6,57	3,46	6,57	4,53	28,96	450	473,21	25,89
	Std.	1,79	0,91	1,54	1,87	1,97	6,09	299,75	380,72	6,70
	Std. Error	0,47	0,24	0,41	0,50	0,52	1,62	80,11	101,75	1,79
15	**Type 2**	9	7,5	5	9	8	38,5	309	104	28
16	**Type 2**	9	8	5,5	9	7	38,5	26	101	22
17	**Type 2**	9	7,5	5	9	8	38,5	100	110	30
18	**Type 2**	8,5	6,5	5	9	7,5	36,5	115	355	36
19	**Type 2**	9	7	4,5	8	6,5	35	392	194	26
20	**Type 2**	7,5	6	3	6	3	25,5	616	138	30
21	**Type 2**	7,5	6	4,5	6	5,5	29,5	217	124	28
22	**Type 2**	9	8,5	4	8,5	7	37	290	368	16

Type 2 Enterprises (n: 8)	**Minimum**	7,5	6	3	6	3	25,5	26	101	16
	Maximum	9	8,5	5,5	9	8	38,5	616	368	36
	Mean	8,56	7,12	4,56	8,06	6,56	34,87	258,125	186,75	27
	Std.	0,67	0,91	0,77	1,32	1,65	4,83	189,23	11,87	5,95
	Std. Error	0,23	0,32	0,27	0,46	0,58	1,70	66,90	39,55	2,10
General (n: 22)	**Minimum**	3	4,5	0	3,5	0	12,5	26	101	15
	Maximum	9,5	8,5	5,5	9	8	38,5	1210	1354	38,5
	Mean	8,09	6,77	3,86	7,11	5,27	31,11	380,227	369,04	26,29
	Std.	1,50	0,93	1,40	1,81	2,08	6,26	276,55	337,34	6,31
	Std. Error	0,32	0,19	0,30	0,38	0,44	1,33	58,96	71,92	1,34

Type 1: modern dairy farms with similar enterprise scales and built without any support from any institution; Type 2 built with the support of the Agriculture and Rural Development Support Institution (ARDSI)

Table 3 Statistical analysis of Animal Needs Index (ANI) scores by enterprise type

Enterprise Type	**n**	**Welfare Categories**					**ANI Score**
		Locomotion	**Social Interaction**	**Flooring**	**Light & Air**	**Stockmanship**	
		$\bar{X}\pm S_x$	$\bar{X}\pm S_x$	$\bar{X}\pm S_x$	$\bar{X}\pm S_x$	$\bar{X}\pm S_x$	$\bar{X}\pm S_x$
Type 1	14	7,82±0,47	6,57±0,24	3,46±0,41	6,57±0,50	4,53±0,52	28,96±1,62
Type 2	8	8,56±0,23	7,12±0,32	4,56±0,27	8,06±0,46	6,56±0,58	34,87±1,70
General	22	8,09±0,32	6,77±0,19	3,86±0,30	7,11±0,38	5,27±0,44	31,11±1,33
P		0,402	0,297	0,050	0,082	0,010	0,013

Type 1: modern dairy farms with similar enterprise scales and built without any support from any institution; Type 2 built with the support of the Agriculture and Rural Development Support Institution (ARDSI)

In animal welfare and SCC, the mean of SCC was found to be 380227.ml^{-1} (SD, 276560; N = 22; Table 4). In the statistical evaluations, there was a negative correlation (r = -0.711) between the ANI score and SCC in overall enterprises (*P* <0.01). In other words, the higher the welfare level in the enterprises, the lower the SCC. A negative correlation (r = -0.658) was found between ANI score obtained from Type 1 enterprises and SCC (*P* <0.05). No correlation was found ANI score obtained from Type 2 enterprises and SCC (*P* >0.05). A negative correlation (r = -0.747, -0.627) was found between SCC and flooring and stockmanship (*P* <0.01). A negative correlation (r = -0.505) was found between SCC and Light and Air condition (*P* <0.05). There was no relationship between SCC and locomotion and social interaction categories (Table 4).

Table 4 The correlation between animal welfare and somatic cell count (SCC; count/ml)

	SCC		
	Type 1	**Type 2**	**General**
ANI	**-0.658***	-0.610	**-0.711****
Locomotion	-0.334	-0.247	-0.344
Social Interaction	0.025	-0.386	-0.256
Flooring	**-0.677****	**-0.773***	**-0.747****
Light & Air	-0.316	-0.639	**-0.505***
Stockmanship	-0.458	-0.482	**-0.627****
SCC	1 000	1 000	1 000
N	14	8	22
Mean ± Std. Error	450 ± 80.11	258,12 ± 66.9	380,22 ± 58.96
Std. Deviation	299.75	189.23	276.55

***P* <0.01; **P* <0.05; Type 1: modern dairy farms with similar enterprise scales and built without any support from any institution; Type 2 built with the support of the Agriculture and Rural Development Support Institution (ARDSI)

The average SCC value overall in the enterprises was 380227 units/mL, the minimum measurement was 26000 units/mL, and the maximum score was 1210000 units/mL (Table 5). When the SCC averages between the two enterprise types were compared, the average SCC for Type 1 was 450000 units/mL and 258125 units/mL for Type 2 enterprises.

In order to determine the relationship between the enterprise types in terms of SCC, the median of the SCC data was calculated; SCC levels were divided into two separate categories as *low* for values below the median and *high* for values above the median. In the Type 1 group, SCC was found *low* in five enterprises (35.7%) and *high* in nine enterprises (64.30%). In the type 2 group, SCC was found to be *low* in six enterprises (75%) and *high* in two enterprises (25%). No relationship was found between enterprise types and SCC (*P* >0.05).

Table 5 Relationship between enterprise types and SCC

		SCC		
		Low	**High**	**P**
Type 1 enterprises	n	5	9	0.183
	%	35.7%	64.3%	
Type 2 enterprises	n	6	2	
	%	75%	25%	

Discussion

There are a total of 47 915 cattle farms of various animal types in Konya. The total number of cattle in these enterprises is 1 196 208. The number of enterprises with more than 100 animals is 1732 (3.62%). This tally can be seen as low. However, when it is evaluated in terms of the number of animals, the number of animals in the enterprises with over 100 cattle is 357672. This number is an important ratio that includes 30% of the total number of animals (RTMAF, 2021).
Enterprise structures in large-scale enterprises are more modern. In addition, enterprise management is done more conscientiously and regular records are kept. In this sense, the reliability of the results increases in the research conducted using the data obtained from large-scale enterprises in general. The average age of the enterprise groups was similar, indicating no difference between the enterprises evaluated in terms of management experience. This similarity in enterprise experience gives us the opportunity to make a more objective assessment among enterprise groups.

The reason for the difference (P <0.05) between the two enterprise types in terms of the scores obtained from the stockmanship category can be attributed to the different sensitivities of the managers and staff working in Type 1 and Type 2 enterprises. In other research, welfare comparisons have been made in enterprises of different sizes. In addition, welfare evaluations have been made by comparing situations, such as whether the animals were tied or not. It is therefore inevitable that there are differences in the welfare scores. In this regard, Koçak *et al*. (2015**)** tried to reveal the animal welfare scores in beef cattle barns with different shelter characteristics (tied or free system) using the Animal Needs Index (ANI) 35L method and reported that enterprises in the free system had higher scores than the enterprises using a tied system (P<0.001). In Japan, Seo *et al*. (2007) in their welfare assessment of dairy cattle farms using the ANI scoring system reported that free-stall herds had markedly higher ANI scores than tied-stall herds, and herds with outside access had higher ANI scores than those without outside access (P <0.05). However, there are not many studies in the literature comparing large-scale and modern enterprises. In this sense, the current study is different from other studies.

In the current study carried out in Konya, the lowest ANI score was calculated as 12.5 and the highest was 38.5. There were some difficulties in scoring welfare criteria. The points awarded during the evaluation may have been affected by the time period the enterprise was visited. The scoring of outdoor areas can be greatly affected by climate; for example, it can be difficult to score an outdoor area covered with snow. Criteria such as cleanliness, floor slipperiness, and animal health are extremely subjective criteria for scoring. Further studies are needed to develop scoring techniques for these criteria. In this evaluation system, the welfare level is naturally higher in free barn herds with outside access.

In the ANI 35L method, the parameters of the barn structure and the administrative practices of the enterprises are evaluated. In other words, it questions the welfare of the environment in which the animal lives, rather than animal-oriented parameters. Animal parameters are recommended by many researchers to determine the welfare level (Johnsen *et al.,* 2001). However, measurement of animal-based parameters requires more work and time (Mazurek *et al.,* 2010). Most of the time, the lack of productivity and health records in enterprises causes difficulties in the evaluation of animal-based parameters. Considering these reasons, the ANI 35L method, which evaluates the suitability of environmental conditions in terms of animal welfare, was preferred in our research.

In a similar study, SCC values were determined to be closely associated with the welfare and hygiene of the environment in which the animals were housed (Tavşanlı *et al.,* 2021). The SCC is an important indicator of milk hygiene, care, feeding, and animal welfare and is affected by barn and barn floors. Such conditions in barns also cause changes in lying behaviour for cattle that spend 50% of their time lying down during the day (Dechamps *et al.,* 1989; Krohn & Munksgaard, 1993). In another study, it was stated that milk quality and SCC obtained from modern farms were better than familial type farms. Therefore, it has been emphasized that there is a relationship between welfare and SCC (Sarıalioğlu & Laçin, 2021). The fact that there is no significant relationship between SCC and locomotion and social interaction is due to the similar scale and structure of the enterprises. However, different conditions were observed in the evaluated enterprises, especially in the flooring, stockmanship, and light and air categories resulting from the maintenance practice and management between the enterprises.

In a related study, it was reported that a healthy mammary gland has an SCC of less than 100,000 cells/mL, and a value higher than 200,000 cells/mL may be the result of many factors such as bacterial infections, milk storage methods and physiological stress that may arise from maintenance and business management (Bradley & Green, 2005). It is important to pay attention to internal and external cleaning in the barns in order to prevent the spread of diseases, prevent the emergence of diseases,

and increase the productivity. It has been reported that the cleanliness of the barn directly affects the hygiene of the cattle and subclinical mastitis is encountered in very dirty animals as a result of insufficient cleaning (De Wolf, 2009). In this case, there will also be an indirect increase in SCC.

No significant relationship was found between enterprise types and SCC in the current study (P >0,05). The reason for this situation can be shown as the similarity between the types of enterprises in terms of structural and herd management.

Conclusion

When welfare assessments in large-scale enterprises in Konya were examined, both types of enterprises generally met the minimum criteria in terms of welfare, whether they were built with the support of ARDSI or not. According to the ANI 35L/2000 welfare measurement method, generally suitable welfare conditions were provided in such enterprises located in the Konya region. However, in addition to providing these welfare conditions, some deficiencies in flooring, stockmanship, and light and air categories were noted. ANI is a good guide for determining the deficiencies of an enterprise in a short period of time. It will be possible to raise the welfare of the enterprises to a higher level with minor adjustments made to the deficiencies identified. Thus, welfare can be improved and diseases such as mastitis and lameness in the enterprises can be reduced. The decrease in SSC in milk will mean that milk is healthier.

In order for enterprises to be more profitable and for animals to be healthy, the system should be evaluated. This includes the development and implementation of relevant legislation, educating enterprise owners on welfare, providing incentives by country governments to increase the welfare of enterprises, and imposing deterrent punishments for enterprises with poor welfare conditions. Aome ANI evaluation criteria, such as cleanliness, floor slipperiness, and animal health, are highly subjective criteria for scoring. Further studies are needed to develop this scoring system and in particular to clarify such criteria. Thus, a more objective evaluation can be achieved by introducing a certain scoring standard to these criteria.

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This study was based on the PhD Thesis by Hasan KESKİN and was approved from the Ethics Committee of the Experimental Animal Production and Research Centre of Selcuk University, Faculty of Veterinary Medicine (SÜVDAMEK), with the decision number 2020/48 (11.06.2020).

Authors' Contributions

MG & HK were in charge of project design; HK was in charge writing the manuscript and project implementation. All co-authors participated in analysis of the data and tabulation and interpretation of the results. This manuscript has been read and approved by all of the authors.

Conflict of Interest Declaration

The authors declares that there is no conflict of interest.

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