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Alternative Animal Feed Additive Obtain with Different Drying Methods from Carrot Unsuitable for Human Consumption

Rabia Göçmen, Gülşah Kanbur, Sinan Sefa Parlat

Abstract**—**This study was conducted to determine that carrot powder obtain by different drying methods (oven and vacuum-freeze dryer) of carrot unfit for human consumption that whether feed additives in animal nutrition or not. Carrots randomly divided 2 groups. First group was dried by using oven, second group was by using vacuum freeze dryer methods. Dried carrot prepared from fresh carrot was analysed nutrient matter (energy, crude protein, crude oil, crude ash, beta carotene, mineral concentration and colour). The differences between groups in terms of energy, crude protein, ash, Ca and Mg was not significant (P>0,05). Crude oil, P, beta carotene content and colour values (L, a, b) with vacuum-freeze dryer group was greater than oven group (P<0,05). Consequently, carrot powder obtained by drying the vacuum-freeze dryer method can be used as a source of carotene.

Keywords**—**Carrot, vacuum freeze dryer, oven, beta carotene.

I. Introduction

CARROT is one of root vegetables containing substances (carotenoid, fibers, etc.) rich in terms of bioactive components. Due to its antioxidant properties, the consumption of carrot and carrot products gains importance every passing day [1]. Carrot, among root vegetables cultivated all over the world, is the most popular. Besides this, in Western countries, also including US, it is one of the most important resources of dietary carotenoids [2], [3]. Carrot contains dry matter in the rate of 14-16% [4]-[7]. It is known that methods of food drying (hot air and freeze dryer, etc.) affect the product quality. The variations in the biological, physical and chemical properties of food stuffs emerge during drying, storage, and distribution. These variations change the physical properties such as color and nature of products. These variations may cause the development of undesirable biochemical changes such as collapse of food stuffs and dissolution of aromatic compounds [8]-[15].

Carrot, due to its nutritional value can be given to animals as cooked or uncooked. Carrot, enjoyed by the dairy cattle, besides it increases the level of Vitamin A in milk, gives a nice appearance and aroma to it.

β-carotene is frequently used in the recent years, in order to increase the productivity of young animals in cows. While β-carotene is used as resource of Vitamin A in ovaries, it serves in tearing of follicle membrane during ovulation [16]. In addition, there is a positive correlation between both the level of β-carotene level in plasma and the fluid of follicle and luteal tissue and weight of corpus luteum [17]. Although it cannot be fully explained how β-carotene increases reproductive performance, its effect is attributed to the change it makes in the uterus environment and its role in the mechanism of reproductive hormone release [18]. β-carotene, in cows and pigs, stimulates the release of progesterone from the luteal cells, consequently, depending on insufficient progesterone release, embryonic death risk, which may likely be shaped [19]. Addition of carotene is also effective on rumen function. *In vitro* growing of rumen bacteria and digestion of cellulose increase as a result of β-carotene addition in the presence of aspire oil and perhaps β-carotene plays a positive role as an antioxidant. Also, β-carotene serves in strengthening the cell membrane and, therefore, can change the composition of long chain fatty acids in the membrane. β-carotene changes rumen hydrogenation, reduces the formation of trans-10 isomers in rumen, and, thus, provides the formation of less milk fat [20].

The number of somatic cell (NSC) that is present in milk is indicator of the health of udder and milk quality. There is a negative correlation between NSC in milk and milk efficiency and some decreases are seen in milk efficiency with increase of NSC [21], [22]. It is reported that in NSC-normal healthy animals, the values of plasm, Vitamin A, and β-carotene are normal, while high NSC animals, these values are at the lower levels [23], [24].

The success in feeding the donor cows depends on the number of total oocyte that is obtained and embryo that is transferable. For donor cows to be fed in a good way, race, age, lived weight, number of lactation, milk efficiency, body condition score, and previous feeding programs should be taken into consideration. Selection of donor cows is the most important step. In feeding the donor cows application of β-carotene becomes effective [25]. β-carotene, particularly due to its transformation into Vitamin A in uterus and ovary, gives positive results and makes an effect increasing the rate of postnatal pregnancy [26]. At the same way, it is known that it improves the meat of animals and skin fat. The carrots that cannot be utilized as a human food can be utilized as animal feed. The color of egg-yolk is an important criterion for consumers and it is affected from the amount of dietary carotenoid. Since carrot is rich in terms of carotenoids, it is a natural pigment. For the color of egg-yolk to form the

Rabia Göçmen is with University of Selcuk, Institute of Science Department of Zootechnics, Konya, Turkey (corresponding author to provide phone: 0332 2232910; e-mail: rabiaacar@ selcuk.edu.tr).
Gülşah Kanbur and Sinan Sefa Parlat are with the University of Selcuk, Institute of Science Department of Zootechnics, Konya, Turkey.

consumer desires, the addition of carrot powder to the laying hen rations can be applied. At the same way, on the broilers, since the color of meat or skin affected the preferences of consumers, the application of interest is also valid in this animal group.

Carrot is a root vegetable containing high amount of water (84-86%). Therefore, its conservation is difficult. The carrot powder, obtained via drying, will provide many advantages especially in terms of animal feeding. The major advantage is storage. In addition, it will be able to be added to rations as feed additive. Drying methods applied directly affect the content of food stuffs. Thus, it is extremely important to identify the drying method, in which the loss of food stuff can be lowered to minimum. Our aim in this study is to investigate the effect of the different drying methods, applied to carrot having high water and especially carotene content, on nutrient content of carrot and whether or not the material obtained will be used as feed additive.

II. Materials and Methods

Carrot material was obtained from Konya Carrot Growers Association. Carrots were not suitable for marketing (small, amorphous, broken etc.). After carrots were washed by city water supply and dried, they were sliced and separated into two groups randomly and for either of groups, method of drying in drying oven was applied and for the other group, method of vacuum freeze dryer. In drying in drying oven, the sliced carrots were dried in drying oven at 70^{o}C for one day. In method of vacuum freeze dryer, the sliced [carrots] were dried in the trays of XO Branded a XOL-55 model freeze dryer at -80^{o}C, under the pressure of 110 Ka, and for 4 days. After drying, the carrots were ground and brought into powder. In the carrot powders obtained, the values of energy, crude protein, crude oil, crude ash, mineral substances (Ca and P), color, and β-carotene were determined. Color analysis was obtained by using calorimeter device (CR-400 Minolta Co, Osaka, Japan) [27].

Variance analysis was applied to the data obtained by using the different drying methods and the results were checked by means of t-test.

The mathematical model of test is as:

$$Yij= \mu +ai+eij$$

In this model, μ= General mean, ai=Effect of drying methods, eij=Error.

III. Result and Discussion

The values and standard errors belonging to the analyzes of carrots, dried by using different methods (drying oven and vacuum-freeze dryer), were given in Table I. In terms of the different drying methods, the differences between the energy, crude protein, crude ash, and Ca and Mg values of the carrots were not found statistically significant ($P > 0.05$). The crude oil content and P value of the carrot powder, obtained by using vacuum –freeze method were found significantly higher than those of carrot powder, obtained by the method of drying oven ($P < 0.05$). The effect of the treatments applied on β –carotene content of carrots was statistically significant ($P < 0.05$). Beta –carotene of carrot powder content by obtained method of vacuum freeze dryer became considerably higher than method of drying oven.

Since poultries are affected from stress factors in view of their physiology, they need an active immune structure. Therefore, feeding the poultries in both maternal and post –hatching periods have a great importance. Carotenes, taken into the body with nutrients, play role in making the free radicals harmless, development of the immune system organs of poultries, and formation of immune response. Maternal-originated carotenes are taken into the body of mother via diet; they are stored in the various tissues, particularly in egg yolk and, via this way, are transmitted in the future generations [28].

TABLE I
Food Composition of Test Groups and Standard Error

Food Composition	Drying Oven	Vacuum-freeze dryer
Energy, kcal/kg	375±8,1	370±7,5
Crude Protein,%	10,2±0,35	9,7±0,26
Crude Oil, %	1,32±0,059^{b}	1,75±0,029^{a}
Beta Carotene, mg/100 g	4,93±0,070^{b}	13,45±0,22^{a}
Crude Ash, %	8,58±0,032	8,39±0,0087
Ca, mg/100 g	69,7±2,4	68,5±1,5
P, mg/100 g	13,3±0,15^{b}	14,5±0,13^{a}
Mg, mg/100 g	74,1±1,2	76,7±1,0

$^{a,\ b}$: Means with different minuscule in the same row are significantly different at P<0.05.

As a result of analysis carried out on the samples of carrot powder, obtained by the methods of vacuum freeze dryer and drying over, while the differences between the levels of the energy, crude protein, ash, Ca, and Mg were not found statistically significant ($P < 0.05$), the value of crude oil and P were found higher in the group of vacuum freeze dryer ($P < 0.005$). The nutritional values of group, on which drying in drying oven was applied, show a high similarity with the values in [29]. The difference between the values of β-carotene was found statistically significant ($P < 0.05$). It was identified that the beta carotene content of carrot powder, obtained by the method of vacuum dryer, was approximately three times higher than that of carrot powder, obtained by the method of drying oven.

In the process of freeze drying, the water, present in food, goes away via sublimation. The process of freeze drying requires that there is no water in liquid state and the low temperatures. In such a condition, since the microbial and other degradations interrupt high quality is provided on the final product. First of all, the nutritional quality of freeze-dried food is maintained at the significant rate [30], [31]. The carotenoid content is an important criterion for determining the quality of dried vegetables such as carrot and yellow squash. Carotenoids are sensitive to the temperature oxygen, light, and enzymes. The large majority of Vitamin A activity in foods (85-97%) depends on the amount of α and β carotene [32]. During drying, the amount of carotene may decrease.

Therefore, it attracts attention to study the effects of drying methods on α and β carotene stability.

While the carotene loss of the carrots, dried in vacuum microwave oven, is less, both α and β carotene contents decreases. While a total of α and β carotene loss is 19.2 % in drying in drying oven, it has been 3.2% in drying in microwave oven. However, in freeze dryer, a significant variation was not identified in either α or β content [33]. Cui et al., [34] reported that carotene accumulation of carrots, obtained via drying in freeze dryer was 95.4 %, while the accumulation in samples dried in drying oven was 70.6 %.

In the studies above mentioned, the results of our present studies are consistent to each other. The carotene contents of carrot powders, obtained via drying in drying oven, decreased due to the fact that they exposed to the temperature for long time. In the method of vacuum freeze dryer, lack of temperature application accounts for the high carotene content.

L, a, and b values of carrot powders and standard deviations, dried by using the different methods (drying oven and vacuum dryer), were presented in Table II. It was found that L, a, and b values of the carrots, for which freeze dryer was used, were statistically higher at significant degree than those of the method of drying oven ($P < 0.05$).

TABLE II
SOME COLOR PARAMETERS

Test Groups	Color parameters		
	L	a	b
Drying oven	32,3±0,64[b]	8,0±0,53[b]	9,1±0,57[b]
Vacuum freeze dryer	60,6±1,3[a]	29,3±0,41[a]	36,2±0,64[a]

a, b : Means with different minuscule in the same row are significantly different at P<0.05.

In measurements, made on the carrot powders obtained via the method of vacuum freezer, the values of L, a, and b had been significantly higher compared to the method of drying oven. Lin et al. [33], in their trials, reported that the slices of carrot, dried in drying oven, were darker colored compared to those dried in vacuum freezer and microwave oven. The brightness of carrot depends on the temperature during drying. As the temperature increase the color becomes darker [35], [36]. The samples dried by the method of freeze dryer, due to the porous structure forming during sublimation of ice are the brightest samples. Porous material may absorb the light more. Therefore, they result in lighter color [37]. The red and yellow color of carrot may be attributed the presence of carotene [38]. "a" values or redness of carrot samples dried in drying oven and vacuum microwave oven had been lower compared to those dried in freeze drier. The possible cause of this situation is the loss of α and β carotene. Purcell et al. [39] reported that color darkening occurring from yellow to red is associated with degradations of chloroplasts and solution of carotenoids in the other cellular lipids after the vegetables containing high carotenoid are heated.

The results of study summarized above are consistent with the results of our study. The color of carrot powder, obtained from the carrots dried via the method of vacuum freezer, had been brighter compared to those dried in drying oven. At the same way, a and b values showing the redness and yellowness had also been higher ($P < 0.05$). The possible reason for this situation is the temperature, to which the samples exposed for 24 hours.

IV. CONCLUSION

According to the results, obtained from the study, when considered that the carrot powder, obtained by using the method of vacuum freeze dryer, contained in much higher amount of β-carotene compared to the carrot powder, dried via the method of drying oven, and it is completely natural in terms of obtained method, it was concluded that carrot powder, obtained by the method of vacuum freezer, can be used as an effective resource of carotene in animal feeding for being able to observe the effects of the use of additives obtained in animal feeding, there is need for studies to be carried out toward using it particularly in broiler rations as natural pigment.

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