INTRODUCTION

In order to increase feed efficiency and body weight gain, growth promoters are usually used as in-feed supplements in broiler feed. They can be categorized as Antibiotic growth promoters (AGP) and Non–Antibiotic growth promoters (NAGP). Antibiotic growth promoters in broiler industry have been used to boost growth efficiency and feed conversion ratios (Dibner and Buttin, 2002; Miles et al., 2006). However, continuous treatment with broiler AGP can result in residues of antibiotics in broiler meat and bacterial resistance against treatments in human body.

In several countries the use of AGP in broiler fattening is therefore prohibited (Botsoglou and Fletouris, 2001; Al- cicek et al., 2004; Owens et al., 2008). NAGP use on the other hand is typically considered to be acceptable alternatives to AGP, as they normally do not carry any risk of bacterial resistance or unwanted contaminants in broiler meat. Organic acids, probiotics, prebiotics, synbiotics, phy- togenics, feed enzymes and immune stimulants are includ- ed in NAGP (Valera et al., 2021; Ikele et al., 2020; Deraz, 2018). Phyto- genics are drawing much attention nowadays. Phyto- genics include antioxidant, antimicrobial, antifungal and antiviral effects and are derived from herbs, spices or...
aromatic plants (Taylor, 2001). One of the most essential herbs or spices, which is much common, is Red Pepper (Capsicum annuum). Red pepper is rich in vitamins C and E and capsaicin (Lee et al., 2010; Shahverdi et al., 2013). Hot red peppers, also known as chili peppers, owe their “heat” to capsaicin (Shahverdi et al., 2013; Al-Kassie et al., 2011).

Approximately 48 percent of the active substances of red pepper are capsaicin (CAP), the most active compound responsible for the pungent effects of hot red peppers (Jancso et al., 1997). Capsaicin is an essential alkaloid and have neurotonic and antimicrobial activity (Fadile and Elife, 2005), as well as may suppress lipid peroxidation effectively (Oboh et al., 2006; Conforti et al., 2007). CAP has many biochemical and pharmacological properties, including antioxidant, anti-inflammatory, anti-allergic and anti-cancer activities (Lee et al., 2005). CAP was more effective in inhibiting lipid peroxidation than vitamin E (Luqman and Razvi, 2006). It is known to increase pancreatic and intestinal enzymes (Plate and Srinivasan, 2004), bile acids (Abdel et al., 2005) and BWG in broiler chicks (Puvača et al., 2015). Hot red pepper is rich in vitamin C, which lead to the reduction of heat stress (Yoshioka et al., 2001; Al-Kassie et al., 2012).

Through managing pathogens, these biotic additives such as Capsicum annuum contribute to the balance of gastrointestinal microbiota. Essential oil extracted from Capsicum annuum has antimicrobial activities against pathogenic bacteria, including Escherichia coli, Clostridium perfringens, and Salmonella enteritidis (Kozukue et al., 2005), and acts as a strong antioxidant, digestive stimulant, anti-inflammatory, and anti-diarrheal agent. It increased return energy consumption and suppressed production in the organs (Frankič et al., 2009; Barbero et al., 2010; Traesel et al., 2010). Herbs and herbal extracts and their oils enhance feed consumption, boost digestive enzyme secretion, and trigger immune function, as well as encourage the anthelmintic, antibacterial, antioxidant, and antiviral activities (Abdelnour et al., 2018). Also, increase the production of beneficial bacteria and restrict various pathogenic bacterial activities in the broiler intestine (Langhout, 2000; Wenk, 2000). So, the goals of this study were to evaluate the impact of hot red pepper oil (HRPO) as natural feed additives (FA) on growth performance, carcass traits and economic efficiency of broilers.

MATERIALS AND METHODS

BIRDS AND MANAGEMENT

This work was carried out during the period from November to December 2019 at El-Bostan Farm, Faculty of Agriculture, Damanhur University. Arbor Acres broiler chicks (n=100), 7 days old, were divided among four treatment groups in a completely randomized design with three replicates per treatment and eight or nine chicks per replicate distributed. They were fed iso-caloric and iso-nitrogenous basal diets containing three levels of HRPO i.e., 0.25, 0.5 and 1 ml/kg diet (T2, T3 and T4 respectively) during the experiment time (7 to 35 days). The Control group (T1) was fed only basal diet without any supplementation. HRPO was observed as having 50 mg capsaicin /ml of HRPO.

During 7-21 and 22-35 days of age, broilers given a commercial mash diet (Table 1). During the preliminary phase (1-6 days of age), chickens were the same starter feed that provided during 7-21 days. The mean indoor temperatures during the 1st, 2nd, 3rd and 4 weeks of age were 34, 32, 30 and 28°C, respectively. Feed and water were given ad libitum. A 23:1h light-dark cycle was given for chicks. During the experimental process chicks were housed under similar management and hygienic conditions. The trials protocol was approved by the Science and Ethics committee of the Faculty of Agriculture, Department of Animal and Poultry production, Damanhur University.

Table 1: Composition of basal diets for studies.

| Ingredients                  | Starter diet (1-21 d of age) | Grower diet (22-35 d of age) |
|------------------------------|------------------------------|------------------------------|
| Yellow corn, kg              | 490                          | 550                          |
| Soybean meal 48% CP, kg      | 420                          | 358                          |
| Di-calcium phosphate, kg     | 20                           | 15                           |
| Limestone, kg                | 10                           | 12.5                         |
| NaCl, kg                     | 3                            | 3                            |
| Vitamin+ premix mineral, kg  | 3                            | 3                            |
| DL-Methionine, nine, kg      | 2.5                          | 2.5                          |
| L- Lysine, kg                | 1.5                          | 2.0                          |
| Vegetable oil, kg            | 50                           | 54                           |
| Total                        | 1000                         | 1000                         |
| ME                           | 3035                         | 3135                         |
| CP                           | 229                          | 208                          |
| Ca                           | 9.5                          | 9.1                          |
| Available P                  | 5.2                          | 4.2                          |
| Methionine                   | 6.0                          | 5.6                          |
| TSAA                         | 9.6                          | 9.1                          |
| Lysine                       | 13.7                         | 12.6                         |
| Ether extra                   | 47                           | 48                           |
| Crude fiber                  | 33                           | 38                           |
| Ash                          | 55                           | 52                           |
| Dry matter                   | 901                          | 912                          |
compound of hot red pepper increases the production of saliva and gastric secretion. Such digestive enzymes activate liver to secrete bile, which further digests food substance. In addition hot red pepper has been reported to encourage digestion and absorption of feed in the digestive tract (Afolabi et al., 2017). Both capsaicinoids and capsaicin from pepper were reported to increase body temperature, consumption of oxygen and promote energy metabolism. The capsaicin in hot red pepper was involved in a stimulant, antiseptic and digestive effect that improved metabolism of carbohydrates by stimulating the sympathetic nervous system. The rise in energy or carbohydrate metabolism would improve the development of more tissues and weight gain or growth (Afolabi et al., 2017).

Economical evaluation were done through calculation of, chick cost (5 LE), Total feed intake /chick (kg), Total feed cost/chick (LE), Price/kg feed (6.7 LE), Fixed cost/chick (1.8 LE), FA cost (LE), Total cost/chick (LE), Price of kg broiler meat at end of the trial (24 LE), Total revenue /chick (LE), and Net margin profit (LE). The economic efficiency evaluation of the HRPO was performed by measuring, FA cost /Total cost%, FA cost /Total return%, Feed intake cost per Kg BWG, Total return/ Total cost% and Net profit/ Total cost%.

Table 2: Impact of HRPO dietary supplementation on growth performance at 7-35 days of broiler chickens.

| Variables                        | Control (T1) | Hot red pepper oil (HRPO) |
|----------------------------------|--------------|----------------------------|
|                                  |             | 0.25ml/kg (T2)            | 0.5ml/kg (T3) | 1ml/kg (T4) |
| Initial live weight (g/bird)     | 141.4±3.39  | 141.6±3.86                 | 142.2±2.64    | 141.3±3.30   |
| Final body weight (g/bird)       | 2279±26.73a | 2316±24.58                 | 2444±30.76a   | 2385±29.57a  |
| Body weight gain (g/bird)        | 2138±29.37a | 2174±66.78                 | 2302±40.03a   | 2244±30.85a  |
| Total feed intake (g/bird)       | 3407±60.06a | 3361±97.80                 | 3427±31.19a   | 3325±78.84a  |
| Feed conversion ratio            | 1.59±0.02a  | 1.55±0.02a                 | 1.49±0.03a    | 1.48±0.03a   |

Means with different superscripts within the same row are substantially different at (p<0.05).

RESULTS AND DISCUSSION

Effect of dietary HRPO suplementation on growth performance of broilers
The finding in Table 2 showed that, the addition of different levels of HRPO into broiler diet significantly (p<0.05) enhanced all productive performance parameters in treated groups relative to control group. The supplemented diet with level of 0.5ml HRPO/kg showed significantly (p<0.05) the highest BWG (2302g/bird) and feed intake (3427g/bird) with best FCR (1.49) among all treatments. Our results can be illustrated by the work of Herati and Marjuki, (2011) where they reported that, the pungent compound of hot red pepper increases the production of...
Table 3: Effect of HRPO dietary supplementation on carcass yield, dressing percentage and certain internal organs as a proportion of broiler final live weight.

| Traits                  | Control (T1) | Hot red pepper oil (HRPO) | 0.25ml/kg (T2) | 0.5ml/kg (T3) | 1ml/kg (T4) |
|-------------------------|--------------|---------------------------|----------------|---------------|-------------|
| Live body weight, g     | 2792±51.34   | 2778±56.00                | 2940±76.54     | 2813±180.84   |             |
| Carcass weight, g        | 2102±26.19   | 2100±32.79                | 2243±63.53     | 2123±145.90   |             |
| Dressing, %              | 75.29±0.59   | 75.6±0.44                 | 76.3±0.21      | 75.5±0.38     |             |
| Proventriculus, %        | 0.29±0.02    | 0.33±0.01                 | 0.28±0.03      | 0.28±0.02     |             |
| Gizzard, %               | 1.28±0.04    | 1.13±0.10                 | 1.02±0.16      | 1.17±0.10     |             |
| Liver, %                 | 1.84±0.06    | 2.07±0.19                 | 2.24±0.04      | 1.89±0.09     |             |
| Heart, %                 | 0.44±0.01    | 0.45±0.01                 | 0.42±0.03      | 0.41±0.02     |             |
| Spleen, %                | 0.07±0.01    | 0.13±0.35                 | 0.07±0.001     | 0.09±0.006    |             |
| Intestine, %             | 3.5±0.09     | 3.89±0.11                 | 3.97±0.20      | 3.7±0.15      |             |
| Pancreas, %              | 0.19±0.006   | 0.22±0.009                | 0.20±0.005     | 0.20±0.002    |             |
| Abdominal fat, %         | 1.34±0.08    | 1.54±0.30                 | 0.93±0.18      | 1.26±0.17     |             |
| Bursa, %                 | 0.17±0.01    | 0.25±0.05                 | 0.20±0.01      | 0.22±0.03     |             |
| Thymus, %                | 0.39±0.04    | 0.49±0.04                 | 0.41±0.04      | 0.40±0.03     |             |

Means with different superscripts within the same row are substantially different at (p<0.05).

Table 4: Effect of HRPO dietary supplementation on overall expenses, total return and net benefit for the study groups (Egyptian pound (LE)/Bird).

| Traits                   | Control (T1) | Hot red pepper oil (HRPO) | 0.25ml/kg (T2) | 0.5ml/kg (T3) | 1ml/kg (T4) |
|--------------------------|--------------|---------------------------|----------------|---------------|-------------|
| Feed intake costs        | 22.8±0.42    | 22.5±0.97                 | 23.0±0.22      | 22.3±0.73     |             |
| Additive costs (HRPO)    | 0            | 0.49±0.02                 | 1.03±0.01      | 1.99±0.07     |             |
| Chick costs              | 5.00         | 5.00                      | 5.00           | 5.00          |             |
| Management costs         | 1.80         | 1.80                      | 1.80           | 1.80          |             |
| Total costs/bird         | 29.6±0.42    | 29.79±0.98                | 30.83±0.22     | 31.1±0.80     |             |
| Broiler weight gain/bird | 2138±29.37   | 2174±66.78                | 2302±40.03     | 2244±30.85    |             |
| Broiler sale/bird        | 51.3±0.72    | 52.2±0.63                 | 55.3±0.92      | 53.8±0.75     |             |
| Total return/bird        | 51.3±0.72    | 52.2±0.63                 | 55.3±0.92      | 53.8±0.75     |             |
| Net profit/bird          | 21.7±0.57    | 23.1±0.70                 | 24.5±0.97      | 22.8±0.57     |             |

Means with different superscripts within the same row are substantially different at (p<0.05).

Abd EL-Haliem, (2019) who stated that, the inclusion of hot red pepper (HRP) in diet resulted in substantial variations (p≤0.05) observed in relative weights of dressing, carcass and offal.

All the measured variables for internal organs (expressed as percentages of live body weight) were statistically improved (p<0.05) with the exception of the heart and intestine (Table 3). Compared to the control diet, the addition of HRPO to broiler diets noticeably (p<0.05) increased percentages of liver, spleen, pancreas, bursa and thymus. The group fed 0.5ml HRPO/kg diet recorded significantly (p<0.05) the highest liver percentage (2.24%) and the lowest abdominal fat percentage (0.93%), as compared to those of liver percentage (1.84%) and abdominal fat percentage (1.34%) recorded for control group. Our results for internal organs may be due to capsaicin in HRPO meal which is pungent or pepperish; it could have challenged the body which in turn stimulated the production of more leucocytes or antibodies that can fight foreign bodies and diseases when the need arises. This would improve the bird's ability to combat pathogens and thus their anti-pathogenic or antibacterial properties (Al-Kassie et al., 2012) and this may be the explanation for the increase in percentages of relative weight of liver, spleen, pancreas, bursa and thymus. The addition of HRPO to broiler diets also, reduce the abdominal fat percentage substantially (p<0.05) as exhibited in Table 3. Our findings align with those of Puvača et al.,
Table 5: Economic efficiency evaluation of HRPO in broiler diet as a natural feed additive (FA).

| Traits                                      | Control (T1) | Hot red pepper oil (HRPO) |
|---------------------------------------------|--------------|----------------------------|
|                                             |              | 0.25ml/kg (T2)           |
|                                             |              | 0.5ml/kg (T3)            |
|                                             |              | 1ml/kg (T4)              |
| FA cost/Total cost, %                       | 0            | 0.02±0.00^a              |
|                                             |              | 0.03±0.00^b              |
|                                             |              | 0.06±0.00^c              |
| FA cost/Total return, %                     | 0            | 0.01±0.00^a              |
|                                             |              | 0.02±0.00^b              |
|                                             |              | 0.04±0.00^c              |
| Feed intake cost per Kg BWG                | 10.65±0.04   | 10.32±0.46               |
|                                             |              | 9.98±0.78                |
|                                             |              | 9.92±0.56                |
| Total return/Total cost, %                 | 1.73±0.02^a  | 1.79±0.02^a              |
|                                             |              | 1.80±0.03^a              |
|                                             |              | 1.73±0.02^b              |
| Net profit/ Total cost, %                  | 0.73±0.02^c  | 0.79±0.02^a              |
|                                             |              | 0.80±0.03^a              |
|                                             |              | 0.73±0.02^b              |

^a-d Means with different superscripts within the same row are substantially different at (p<0.05).

Effect of HRPO supplementation on overall expenses, total return and net benefit

The findings obtained from the assessment of the economic component of the experiment were presented in Table 4. It showed a substantial increase in feed costs and total costs (p < 0.05) with an increase in dietary HRPO levels. Total costs of feed (feed intake costs + FA cost) ranged from 22.8 – 24.29 Egyptian pound (LE)/bird for control group and those fed diets with 1ml HRPO/Kg diet, respectively. While, total costs (LE/bird) ranged from 29.6-31.1 for control group and those fed diets with 1ml HRPO/Kg diet, respectively. All treated groups with HRPO showed the highest return and net profit compared to the control group. Total return (LE/bird) ranged from 51.3-55.3 for control group and those fed diets with 0.5ml HRPO/Kg diet, respectively. Net profit (LE/bird) ranged from 21.7-24.5 for control group and those fed diets with 0.5ml HRPO/Kg diet, respectively. Our results agreed with those of Abd EL-Haliem, (2019) where he reported the highest return and net profit achieved by treated groups with HRP than those of control group in growing Japanese quails. Diet containing 0.2% HRP recorded the highest net profit.

Economic efficiency Evaluation of HRPO in broiler diet as a natural feed additive (FA)

Evaluation of economic efficiency of dietary supplementation of extracted hot red pepper oil is shown in Table (5). The cost of feed additive (HRPO) used in experiment in comparison with total costs and total return were very little. The increase in production costs with the addition of HRPO to the chickens’ diet compared to chickens without natural additive supplementation is negligible. These can be explained as by very little additional costs to broiler diet we can get a significant increase into return and net profit of broiler fattening project (economically efficient). Also, costs of feed intake per kg BWG differed significantly at (p<0.05). For birds fed control diets, the highest cost of feed intake per Kg BWG (10.65 LE) was obtained, whereas for birds fed with 1 ml HRPO/kg diet, the lowest feed intake cost per Kg BWG was obtained. The return and net profit from each Egyptian pound invested in broiler fattening in the three experimental groups is higher than that of control group. The highest return from each invested pound (1.80%) and highest net profit from each invested pound (0.80%) recorded in birds fed diet contain 0.5ml HRPO/kg. Diet contain 0.5ml HRPO/kg considered the most economically efficient diet as it recorded the highest final live body weight and the highest return and net profit for each Egyptian pound invested into broiler chicks fattening.

CONCLUSIONS

Inclusion of 0.5ml to 1ml/kg hot red pepper oil in broilers’ diet increased their production efficiency at a lower cost and had no adverse effect on broiler carcass and their internal organs. Thus, HRPO could be used in broilers’ diet as a replacement of antibiotic growth promoters as it has improving effect on broilers’ performance and economic efficiency. Due to a natural source, it could be hypothesized that inclusion of HRPO will not have any deleterious effects on meat quality of broilers. However, further research on its effects on meat quality (like technological and sensory) should be investigated.
REFERENCES

Abdel OME, Heikal OA, El-Shenawy SM (2005). Effect of capsaicin on bile secretion in the rat. Pharmacol. 73: 121-128. https://doi.org/10.1159/000081954

Abdelnour S, Alagawany M, El-Hack ME, et al., (2018). Growth, carcass traits, blood hematology, serum metabolites, immunity, and oxidative indices of growing rabbits fed diets supplemented with red or black pepper oils. Animals. (8): 168. https://doi.org/10.3390/ani8100168

Afobalik BD, Ndelekweutie EK, Alabi OM, et al., (2017). Hot Red Pepper (Capsicum annuum L.) Meal Enhanced the Immunity, Performance and Economy of Broilers Fed in Phases. Journal of Biology, Agric. Healthcare. 7(8): 2224-3208.

Alcicek A, Bozkurt M, Cabuk M (2004). The effect of a mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. S. Afr. J. Anim. Sci.; 34:217-222.

Al-Kassie GAM, Al-Nasrawi MAM, Ajeena SJ (2011). The effects of feed supplemented mixture of hot red pepper and black pepper on the performance and some hematological broiler traits in broiler diet. Int. J. Adv. Biol. Res. 2(1):53-57.

Barbero GF, Molinillo JM, Varela RM, et al., (2010). Application of Hansch’s model to capsaicinoids and capsinoids: A study using the quantitative structure-activity relationship. A novel method for the synthesis of capsinoids. J. Agric. Food Chem. 58:3342–3349.

Botsoglou NA, Fletouris DJ (2001). Drug Residues in Foods: Pharmacology, Food Safety and Analysis. Marcel Dekker, Inc. Publ., New York, USA.

Conforti F, Statti GA, Menichini F (2007). Chemical and biological variability of hot pepper fruits (Capsicumannum var. acuminatum L.) in relation to maturity stage. Food Chem. 102: 1096-1104. https://doi.org/10.1016/j.foodchem.2006.06.047

Deraz SF (2018). Synergetic effects of multispecies probiotic supplementation on certain blood parameters and serum biochemical profile of broiler chickens. J. Anim. Health Prod. 6(1): 27-34. https://doi.org/10.17582/journal.jahp/2018/6.1.27.34

Dibner JJ, Buttin P (2002). Use of organic acid as a model to study the impact of gut microflora on nutrition and metabolism. J. Appl. Poult. Res. 11:453-463. https://doi.org/10.1093/japr/11.4.453

Fadile YZ, Elife O (2005). In vitro activity of capsaicin against Helicobacter pylori. Ann. Microbiol. 55: 125-127.

Franki TM, Voljé J, Salobir M, et al., (2009). Use of herbs and spices and their extracts in animal nutrition. Acta Agric. Slov. 94:95-102.

Haiam S Abd EL-Haliem (2019). Effect of hot red pepper on productive performance and carcass characteristics of growing Japanese quail. Egyptian J. Anim. Prod. 56(3):139-145. https://doi.org/10.21608/ezap.2019.92993

Herati, Marjuki (2011). Effect of feeding red ginger asphytotrophic on broiler slaughter weight and meat quality. Inter.J.Poult. Sci.,10(12): 983-986. https://doi.org/10.3923/ijps.2011.983.986

Ikele OM, Ezeonu IM, Umeh CN (2020). Prebiotic roles of Ocimum gratissimum extract in the control of colibacillosis in broilers. J. Anim. Health Prod. 8(4): 206-211. https://doi.org/10.17582/journal.jahp/2020/8.4.206.211

Jancso G, Kiraly E, Jansco–Gabor A (1997). Pharmacologically induced selective degeneration of chemo sensitive primary sensory neurons. Nature. 270: 741–743. https://doi.org/10.1038/270741a0

Kozukiue N, Hao JS, Kozukiue E, et al., (2005). Analysis of eight capsaicinoids in peppers and pepper-containing foods by high-performance liquid chromatography and liquid chromatography-mass spectrometry. J. Agric. Food Chem. 53:9172–9181. https://doi.org/10.1021/jf0504699

Langhout P (2000). New additives for broiler chickens. World Poult. 16:22–27.

Lee SH, Lillehoj HS, Jang SIK, et al., (2010). Effect of dietary Curcuma, capsicum, and lentinus on enhancing local immunity against, Eimeria a Cevilian infection. J. Poul. Sci. 47:89-95. https://doi.org/10.2141/jpsa.0009025

Luqman S, Razvi SI (2006). Protection of lipid peroxidation and carbonyl formation in proteins by capsaicin in human erythrocytes subjected to oxidative stress. Phytotherap. Res. 20: 303-306. https://doi.org/10.1002/ptr.1861

Miles RD, Butcher GD, Henry PR, et al., (2006). Effect of antibiotic growth promoters on broiler performance, intestinal growth parameters, and quantitative morphology. Poul. Sci.; 85:476–485. https://doi.org/10.1093/ps/85.3.476

Oboh G, Puntel RL, Roche JBT (2006). Hot pepper (Capsicum annuum, Tepin and Capsicum Chinese, Habanero) prevents Fe2+ induced lipid peroxidation in brain in vitro. Food Chem. 102: 178-185. https://doi.org/10.1016/j.foodchem.2006.05.048

Owens B, Tucker L, Collins MA, et al., (2008). Effects of different feed additives alone or in combination on broiler performance, gut microflora and ileal histology. Brit. Poul. Sci.; 49:202-212. https://doi.org/10.1080/00071660802004890

Platel K, Srinivasan K (2004). Digestive stimulant action of spices: a myth or reality? Indian J. Med. Res. 119: 167–179.

Puvacva N, Kostadinovic Lj, Ljubojevic D, et al., (2015). Effect of dietary red hot pepper addition on productive performance and blood lipid profile of broiler chickens. First International Symposium Vet. Med.. At :https://www.researchgate.net/publication/277018793

Shahverdi AF, Kheiri M, Faghan M, et al., (2013). The effect of the use of red pepper (Capsicum annuum L) and black pepper (Piper nigrum L) on performance and hematological parameters of broiler chicks. European J. Zool. Res. 2(6):44-48. http://scholarsresearchlibrary.com/archive.html.

Taylor DJ (2001). Effects of antimicrobials and their alternatives. Brit. Poul. Sci.; 42:67-68.

Traesel CK, Walkner P, Schmidt C, et al., (2010). Serum biochemical profile and performance of broiler chickens fed diets containing essential oils and pepper. Comp. Clin. Pathol. 20:453-460. https://doi.org/10.1007/s00580-010-1018-1

Valera M, Casasola R, Gutiérrez O, Sánchez-Chiprés DR, Mireles S (2021). Effects of supplementation with a novel organic chromium product on metabolic and physiological indicators of broilers. J. Anim. Health Prod. 9(1): 13-21. https://doi.org/10.17582/journal.jahp/2021/9.1.13.21

Wenk C (2000). Why all the discussion about herbs? Pages publication/277018793

Yoshioka M, Doucet E, Drapeau V, Dionne I, Tremblay A
(2001). Combined effects of hot red pepper and caffeine consumption on energy balance in subjects given free access to foods. Brit. J. Nutrit. 85: 203-211. https://doi.org/10.1079/BJN2000224