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MONITORING CHANGES IN COWPEA COLOR AND STORAGE CONDITIONS

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Abstract

The optimum and safe storage treatment for cowpea and evaluate changes in quality during storage in different types of hermetic bags. Using two different pre-conditioning methods infrared heating and ultraviolet radiation compared with Non-treated on cowpea seeds before storage process. The aim of this study to discrimination of color change for Cowpea seeds were treated by FIR and ultraviolet UVC irradiation intensity, the seeds was stored in woven and hermetic bags (three & seven layers), the differences in Red color band increased from 161.3 to 197 when using the seeds that irradiated with FIR radiation and stored in 3 and 7Layers bag,, while at woven bag increased to 247.6 the differences in intensity I_2 increased by using UVC radiation and stored in woven bag and the differences in R/G increased by 9.5% when using in the seeds that irradiated with FIR radiation and stored in three layers bag. the differences in Hue increased by 7.14% when using the seeds that irradiated with UVC and stored in three layers bag, The moisture content of seeds stored in woven bags increased to 14.82% in contrast with both types of hermetic bags which approached to 10.8% and 10.7% of three layers and seven layers bags respectively due to moisture absorption from surrounding air and also the released moisture due to high respiration rate of seeds and microorganisms. Seven-layer bags recorded the highest levels of Carbon dioxide concentration inside the bags which arrived at the end of storage period to 24.8%, 20.9 % and 20.5% for non- irradiated, infrared irradiated and ultraviolet irradiated bags respectively. Carbon dioxide inside the three-layer bags were to 19.7%, 16.9 % and 16.2% for the non -irradiated, infrared irradiated and ultraviolet irradiated treatments in respectively.

Key words: *Cowpea, color, radiation, UVC, FIR , storage, hermetic bags*

INTRODUCTION

Cowpea is a nutritionally food in the human diet. Cowpea has a high protein and carbohydrate content, a low fat, and integral amino acid pattern to cereal grains, Rebello et al. (2014) showed that the legume seeds nutritional benefit, also known as pulses, resides in their nutritional value, including large quantities of carbohydrates (30% to 40%), proteins (from 17% to 40%), dietary fibre (from 8% to 27.5%), fat (from 5% to 47%), and with sufficient quantities of essential amino acids like leucine, arginine, and lysine [20]. Elhardallou, et al. (2015) mentioned that a lack of sulphur-having amino acids slows of digestibility, and anti-nutritional factors like trypsin inhibitors, phenolic compounds and oligosaccharides, are all major limiting factors for cowpea consumption in a typical diet [6]. However, proper methods of processing could be used to reduce antinutritive factors and increase bioavailability, particularly at consuming. Jayathilake et al. (2019) reported that Cowpea protein source is a high-quality plant that is commonly consumed [14]. Cowpea is a nutritionally food in the human diet. Cowpea has recently sparked widespread interest among consumers and researchers due to its health-promoting properties, which contain anti-cancer, antihypertensive, anti-hyperlipidemia, anti-inflammatory, and anti-diabetic properties.

Cowpea are more difficult to store than cereals and they suffer much greater damage from insects and microorganisms. This not only results in quantitative losses, but also in qualitative reduction of the nutritive value because of vitamin loss and deterioration of protein quality. The losses due to insect-damaged grain are even higher as more breakage and powdering occur with such grain. Mason et al. (2012) found that for stored grain insects, the most favorable grain moisture content level is 12 to 18 percent [18]. In certain cases, insect infestation exacerbates mold problems in grain by exposing mold-prone endosperm surfaces, transferring mold spores to new locations, and promoting mold germination in microhabitats rendered moist by insect metabolic activity. Suleiman and kurt (2015) [23] told that molds and fungi that develop in grains and seeds during storage and transportation cause germination, discoloration, musty or sour odors, caking, nutritional and chemical changes, the formation of mycotoxins and manufacturing quality reduction.

The application of infrared heating FIR of cowpeas revealed an improvement in the cooking characteristics, increasing the water uptake of seeds during soaking and improving in the sensory qualities of seeds such as appearance, flavor and texture. Infra-red heating also reduces moisture content of seeds and used as sterilization process to seeds before storage. On the other hand, Ultraviolet radiation (UVC) is non-thermal method (physical method) mainly used for microbial disinfection. Exposure of microorganisms to UVC light affecting the DNA. Mwangwela et al. (2007) [19]. reported that Pinto beans, black beans, green peas, kidney beans, cow peas, lentils, and soy beans were analyzed to see how infrared treatments affected their properties. The legumes were heated to 140°C on the surface, they found that valuable changes in the seeds' physical characteristics the function of the trypsin inhibitor was decreased. The starch and protein content of the seeds were not affected by infrared heating. Krishnamurthy et al. (2010)[16]. reported that far-infrared radiation can be used for the heating of food systems and inactivation of pathogens because of higher absorption of energy in the far-infrared wavelength range (3 to 1,000 μm) by microorganism and food components. Therefore, infrared heating has the potential to inactivate microorganisms in foods. The food substances absorb FIR energy most efficiently through the mechanism of changes in the molecular vibrational state, which can lead to radiative heating. The main components of food, absorb FIR energy at wavelengths greater than 2.5 μm. Sun (2012) [24]. mentioned that there are two types of natural water molecule vibrations: vibration of symmetrical deformation and vibration of symmetrical stretching. The body absorbs infrared energy that is related to certain frequencies effectively. As a result of the change in the state of vibration of the vibration process, the food absorbs infrared radiation efficiently at wavelengths greater than 2.5 μm, causing its temperature to increase (heating).

UV light is used in a variety of applications in the food industry. High-performance UV light sources and equipment can clean, wash, and process water, air, and surfaces. In a cost-effective and environmentally friendly way, the chemicals used may be reduced or even removed. Souza et al. (2004) [22] The wavelength of UV-light is divided into three bands—UV-A, UV-B, and UV-C, the long (UV-A, 400–320 nm) and middle (UV-B, 320–280 nm) wavelengths are present in sunlight and have some germicidal value. However, the short wavelengths or UV-C (280–100 nm) has high germicidal capacity and do not naturally exist, having to be produced by the conversion of electric energy. Howarth (2007) [13] noted that ultraviolet light as a nonchemical disinfection process is gaining popularity due to its germicidal properties. The ultraviolet method's equipment has a low operating cost, apart from being an eco-friendly technology that reduces the need for many chemical treatments, it is also capable of providing high standards of protection. Koutchma (2019) [15] described that ultraviolet-C treatment is a nonthermal procedure that has been licensed for use as a disinfectant for the surface treatment of food products. Ultraviolet-C treatment leaves no trace in the treated products. Unlike the majority of organic disinfectants, ultraviolet-C radiation deactivates pathogen microorganisms by transmitting energy of electromagnetic from a transmitter, such as a germicidal lamp (λ = 253.7 nm), to the nucleic acids of the microorganisms by a photochemical reaction. Fouda, et. al (2021) [8] study effect of infra-red and ultraviolet radiation on sterilization and trypsin inhibitor deactivation of cowpea seeds the results showed that, for infra-red pre-treatment the irradiation intensity of 882.67 w/m2 at exposure time of 15 min. Is recommended. At this level of radiation intensity and exposure time, the total microbial count was 2.3 log cfu/g., protein content 28.88 %, trypsin inhibitor 1.148 tiu/mg and moisture content 8.13 % w.b. Meanwhile, for the uvc pre-treatment, irradiation intensity of 3.538 mw/cm2 and exposure time of 40 mins is recommended to get total microbial count of 2 log cfu/g., protein content 28.15%, trypsin inhibitor 0.57 tiu/mg and moisture content 10.95%.

Also considering the period of shelf life of seed and different types of barriers films. Aboagye et al. (2017) [3] studied the parameters evaluated were the moisture content, insect infestation, usable proportion, and 1,000 grain mass in both hermetic and non-hermetic systems. Also the effect of hermetic and non-hermetic storage on cowpea in plastic containers in the tropics area. The cowpeas were stored in hermetic and non-hermetic containers over a period of 12 weeks. The results showed that the number of live insects drastically reduced to zero in the hermetic system from the fourth week to the twelfth week,. The moisture content in the hermetic containers increased slightly from 11.7 to 11.9% compared to a sharp increase from 11.7 to 17.2% in the non-hermetic plastic containers. Also, the mass of 1,000 grains reduced from 156.50 g on week zero to 145.21 g in the non-hermetically stored grains, while the hermetically stored grains recorded a decrease to 148.95 g. In the case of the non-hermetic containers, the population of live insects/100 g of grains increased from 5 on week 0–71 on the twelfth week. Finally, the usable proportion of grains in the hermetic system declined from 98.55 to 94.80% after 12 weeks of storage as compared to the drop to 85.69% seen in the non-hermetic system.

Silva et al. (2018) [21] the use of modified atmosphere through hermetic storage in polyethylene silo bags and polyethylene terephthalate (PET) bottles as a technique to preserve the quality of cowpeas during storage. Cowpea grains were stored in polyethylene silo bags, polyethylene terephthalate (PET) bottles and glass recipients (control) for 30, 60, 90 and 120 days. The moisture content, bulk density, germination percentage and electrical conductivity of the cowpeas were preserved in both hermetic storage systems that were tested for 120 days.

CIE. (1989) [5] designated specific wavelengths to the primary colors: Red 700 nm, Green 546.1 nm, and Blue 435.8 nm. The color analysis of the seeds was based on an RGB histogram of pixel values tested. RGB representation is important in digital image processing due to its wide use in digital imaging hardware, such as color cameras and monitors. Lebert (1992) [17] Color of the packaged product, though, is the first quality parameter that the consumer perceives. Also Sensory properties of the legumes, such as, aroma, flavor, texture, and color are significant. The color is the most important parameter describing the quality of beans. This is in agreement with various large-scale consumer studies in which 40–60% of grade points, related to quality, were assigned to color.

Francis (1994) [10] showed that the color of beans is changing during storage, affecting the desirability of the product by the consumers. Colorimetric techniques have been used to determine the reaction kinetics constants for the discoloration of vegetables. Color deterioration of foods, occurring during storage is due to either an enzymatic action or a chemical reaction. Non-enzymatic browning is due to either oxidative browning or non-oxidative browning in the absence of oxygen, as a result of chemical reactions between proteins and reducing sugars.The enzymatic browning usually occurs in cases where enzymes are activated, often after a cut of the product, and results in very rapid change of the color. Considering the typical shelf life of beans (1–2 years), the mechanism of color deterioration during storage is probably due to both enzymatic and chemical browning.

Francis (1995) [11] mentioned that appearance is one of the major factors the consumer uses to evaluate the quality of food products. The appearance of a product as judged by its colour can often be used to determine the pigment content of a product, which in turn is often an index of quality.

Berrios, Swanson and Cheongh (1998) [4] thought that complex reactions are activated inside the grains, involving different cell components such as cell wall polymers, phenolics, starch, protein and enzymes, initiating the hardening and/or darkening phenomena.

Gonzalez and Woods (2002) [12] showed that Color is considered a fundamental physical property of agricultural products and foods. Human perception of color is a function of the response of three types of colors, that are blue, green and red.. The eyes interpret the incoming light into three colors and finally the three colors are received by the brain and re-interpreted as the complete spectrum in the form of a color circle. There are common indicators used to recognize ripeness of the agricultural products and thus determine the best time to harvest the products. Unay and Gosselin (2002) [25]. stated that a co-occurrence matrix is a square matrix whose elements correspond to the relative frequency of occurrence p (i, j) of two-pixel values (one with intensity i and the other with intensity j), separated by a certain distance d in a given direction.

Fouda,T. and Salah, S (2014) [7] showed the relationships between hue and saturation and total soluble solid acidity and percentage of liquid. The multiple regression analysis and correlation coefficient was used to test the association between some chemical properties different hue and saturation to ranked the more suitable maturity indices. The results obtained in this research demonstrated that hue and saturation indices gives understanding about between total soluble solid, acidity and percentage of liquid. The coefficient of determination at all properties equation of saturation indices more than with hue indices. Fouda and Albebany (2021) [9]. Color can distinguish between different varieties of wheat imported from different countries. It is also possible to distinguish between Ergot fungi sclerotia and between different types of imported wheat, and the color indicators used showed a clear contrast between wheat and Ergot fungi sclerotia, for example. The physical specifications also showed the differences that distinguish between mushrooms and wheat, which can be used to design the sieve holes for the specific separation.

The main objectives of this study to evaluate the changes in cowpea quality during storage of pre-treated cowpea in different types of hermetic bags, store cowpeas as long as possible without biological infestation, determine the appropriate bag for storage, Also determine the relations shapes between color and protein content, trypsin enzyme inhibitor, and total microbial count and determine the safe limits for the use of ultraviolet and infrared radiations with cowpea seeds.

MATERIALS AND METHODS

Materials

Before storage Cowpea in different types of barriers films were treated with by different pre-treatment methods of infrared and Ultraviolet for sterilization and deactivation of trypsin inhibitor

Cowpea seeds

The cowpea seeds var. (Dokki 126) were used for this experiment. The tested samples were obtained from EL Aiatt, Giza Governorate, Egypt.

The infrared heating unit was used as thermal treatment for the experimental work . A rotary cylinder made of 1 mm galvanised iron sheet (0.6m diameter and 0.2m long) is enclosed by a fixed insulated cylinder (0.8m diameter and 0.3long).

Ultraviolet radiation unit

Cowpea was conducted using a prototype irradiator consisting of two UVC lamps (4136 G36T6-20W - 254 nm), the length of the lamp is 60cm. The unit body was made of metal sheet plated with electrostatic substances (820 mm length and 520mm width), the inside

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surface of the unit is made of stainless steel 304 with a door made of poly carbonate for protection from uv-c radiation.

Hermetic bags

Two different types of barriers films were used for the experimental work. The materials specifications of the barrier films were assessed in the laboratory of Shuman company.

Methodology

The pre-condition process was done, and the optimum treatment for both pre-conditioning methods (Infra-red and ultraviolet) in terms of reduction moisture content, preserving protein content, deactivate trypsin inhibitor, and reduction of total microbial account were chosen for safe storage process the statement of experiments showed in Fig. 1. The produced bags were filled by the non-heat-treated cowpea at initial moisture content of (10.95%) w.b% and pre-treated cowpea seeds with the most proper intensity and exposure time for both examined pre-conditioning methods as follows:

-For infrared conditioning treatment, the radiation intensity of 882.67W/m^2 and an exposure time of 15 min was selected for storage process.

-For ultraviolet conditioning treatment, the radiation intensity of 3.538 mW/cm^2 and an exposure time of 40 min was selected for storage process.

-The storage experimental was conducted under the following steps:

1-Fill cowpea in different types of examined bags at capacity of 20 Kg/bag and close the bags previously using the heat-sealing apparatus.

2-Store the bags in a proper storage room in the three groups (three layers- seven layers- woven bags). Each group contain 9 bags with capacity 20Kg/ bag.

Take monthly measurements of carbon dioxide, oxygen gas, temperature and relative humidity inside the stored bags of each group.

Take samples from each experimental bag for quality evaluation tests including moisture content measurements, protein, total microbial count.

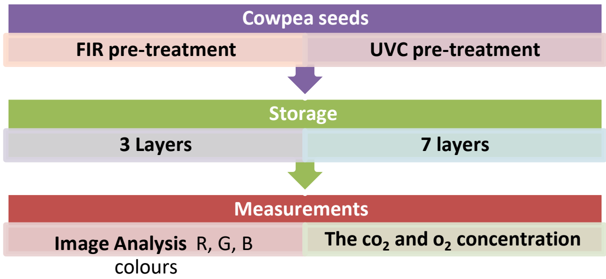

Fig. 1. The experiments statement
Source: Authors' drawing.

Measurements

-**The CO_2 and O_2 concentration** was monitored in every month using co$_2$ and o$_2$ sensor (VI GAZ "Gas analysis- model Box 121, (VI GAZ Company, France).

-**Moisture content** was determined by the standard oven method. Samples were taken before and during the drying and weighted oven dried to constant mass at 105°C for 24 hours (AOAC, 1990) [1].

-Monitoring CO2 and O22 concentration

The CO2 and O2 concentration was monitored in every month using CO2 and O2 sensor (VI GAZ "Gas analysis- model Box 121, (VI GAZ Company, France).

-Total microbial count

Total microbial count activity was determined following the methodology about 25 g from the samples was transferred in to a stomacher bag (Seward, London, UK), and homogenized with 225 ml of sterile saline peptone water (SPW: 1g/1 peptone, 8.5g/l sodium chloride) for 3 min .

-Insect detection (insect/kg)

The cowpea seeds were sieved and the weevils were identified according to (AOAC, 2000) [2].

-**Color Analyzer Model**: RGB-1002 were used.

The RGB-1002 is a portable color analyzer equipped with an external sensor probe having a 45°/0° color measuring geometry. The modem, accurate microprocessor technology uses the spectral analysis method to determine the color of the sample. Excellent repeatability due to the use of spectroscopic analysis technique. To get the color value (R, G, B or H, S, I).

RESULTS AND DISCUSSIONS

Storage performance

The moisture content, Oxygen and Carbon dioxide concentration, Total microbial count and seed color indices affected by storability time and using infra-red (IR) and ultraviolet (UVC) intensity as a pre-conditioning process of cowpea seeds

The moisture content

The effect of different irradiation and Type of bag during storage period on moisture content of seeds is shown in Table 1. The initial cowpea moisture content was 10.95 % w.b and the final cowpea moisture contents woven .bag were (14.82, 10.82 and 9.1 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. While when used 3-layer bag the final cowpea moisture contents Woven. bag was (10.80, 10.60 and 8.28 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. Also, when used 7-layer bag the final cowpea moisture contents woven bag were (10.70, 10.55 and 8.20 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively.

Table 1. Seeds moisture content inside the bags with and with out radiation

Treatment	Storage period day	Type of bag		
		Woven. Bag	3-layer bag	7-layer bag
not – irradiated	1	10.95	10.95	10.95
	240	14.82	10.8	10.7
ultraviolet radiation.	1	10.73	10.89	10.82
	240	10.82	10.6	10.55
Infra-red radiation	1	8.13	8.13	8.13
	240	9.1	8.28	8.2

Source: Authors' determination.

Oxygen concentration

The effect of different irradiation and Type of bag during storage period on Oxygen concentration is shown in Table 2. The initial Oxygen concentration was 19.80 % and the final Oxygen concentration in Woven. bag were appear little changes at not – irradiated , ultraviolet radiation and Infra-red radiation respectively. While An obvious change occurred when used 3 and 7 layer bag Oxygen concentration of woven bags were closed to the atmospheric levels.

Table 2. Oxygen concentration % inside the bags with and without radiation

Treatment	Storage period day	Type of bag		
		Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	19.9	12.5	8.9
	240	19.2	6.7	5.5
ultraviolet radiation.	1	19.60	17.90	17.30
	240	19.30	8.40	8.10
Infra-red radiation	1	19.5	17.5	17.1
	240	19.3	7.5	7.3

Source: Authors' determination.

Carbon dioxide concentration

The effect of different irradiation and Type of bag during storage period on Carbon dioxide concentration is shown in Table 3. The initial Carbon dioxide concentration 0.1 and the final Carbon dioxide concentration in Woven. bag were appear little changes at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. While An obvious change occurred when used 3 and 7 layer bag

Table 3. Carbon dioxide concentration inside different types of bags with and with out radiation

Treatment	Storage period day	Type of bag		
		Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	0.1	3.9	4.5
	240	0.7	19.7	24.8
ultraviolet radiation.	0.1	3.1	3.5	0.1
	0.7	16.2	20.5	0.7
Infra-red radiation	1	0.1	3.5	4.3
	240	0.6	16.9	20.9

Source: Authors' determination.

For both studied types of hermetic storage bag the average oxygen concentration decreased and carbon dioxide increased to levels prevents growth of microorganisms and insects depends upon seeds condition and the pretreatment method. The average levels of O2 ranged from 19.8% to 5.5% and the level CO2 ranged from 0.1% to 24.8%.

Total microbial count

The effect of different irradiation and Type of bag during storage period on total microbial count of cowpea seeds. As shown in the Table 4, the total microbial count (TMC) reduced from 4.6 to 3.1 (Log10 CFU/g) at not – irradiated with 3-layer bag and reduced from 4.5 to 2.8 (Log10 CFU/g) at not – irradiated with 7-layer bag. While at ultraviolet radiation management reduced from 2.00 to 1.70 (Log10 CFU/g) with 7-layer bag and reduced from 2.1 to 2.1 (Log10 CFU/g) at Infra-red radiation with 7-layer bag. Continuous increase in microorganisms' infection was detected for the seeds stored in pp woven bags under the three conditions of seeds (not irradiated, FIR irradiated and UVC irradiated). Whereas the rate of seeds infection was lower for the seed stored in both types of hermetic bags. Hermetic storage bags that filled with the irradiated seeds ultraviolet or infra-red heating process showed no insects at the end of storage period however the woven bags contained live populations of cowpea weevil insect (*Callosobruchus maculatus*) recorded 81 insect/kg for the non-treated seeds, 13 insect/kg for irradiated seeds with IR and 11 insect/kg for the heat-treated seeds with UV.

Table 4. Total microbial count inside different types of bags with and without radiation

Treatment	Storage period day	Type of bag Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	5	4.6	4.5
	240	5.68	3.1	2.8
ultraviolet radiation.	1	2.2	1.9	2
	240	3.8	1.9	1.7
Infra-red radiation	1	2.5	2.1	2.2
	240	3.7	2.1	2.1

Source: Authors' determination.

Optical properties of cowpea seeds

The results show high variances in color indices for cowpea stored with different types of hermetic bags were treated with infrared and ultraviolet radiation showing in Figure 2 to 7 Color indices RGB color, Red/ Green ratio, his color intensity I_1, I_2 and color saturation Hue were tested as color properties for cowpea during storage period with different bag types. The highest and lowest value of Red band ranged from 254 to 123 were observed in the seeds that irradiated with UVC and stored in woven bag and the seeds that non irradiated and stored in three layers bag as shown in Figure 2, while the highest and lowest value of green band ranged from 183.3 to 88.6 as shown in Figure 3 and 4 for blue band for the seeds that irradiated with infrared and stored in woven bag and the seeds that non irradiated and stored in three layers bag as shown in Figure 4.

Figure 4 illustrates the relationship between hue and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest and lowest value of Hue ranged from 0.56 to 0.42 were observed in the seeds that irradiated with UVC and stored in three layers bag and the seeds that irradiated with infrared and stored in three layers bag. Figure 5 and 6 show the relationship between intensity and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest value of intensity i1 and i2 (182.3 - 75.8) were observed in the seeds that irradiated with infrared and stored in woven bag and irradiated with UVC and stored in woven bag but the lowest value of intensity one and two (87.2 - 35.6) were observed in the seeds that non irradiated and stored in three layers bag and non-irradiated and stored in seven layers bag. Figure 7 illustrates the relationship between R/G and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest and lowest value of r\g (1.57-1.27) were observed in the seeds that irradiated with infrared and stored in three layers bag and the seeds that non-irradiated and stored in the woven bag.

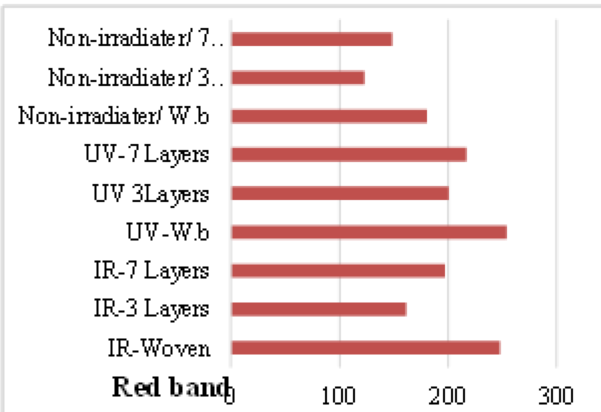

Fig. 2. Relationship between red band and different conditions of cowpea seeds stored day.
Source: Authors' determination.

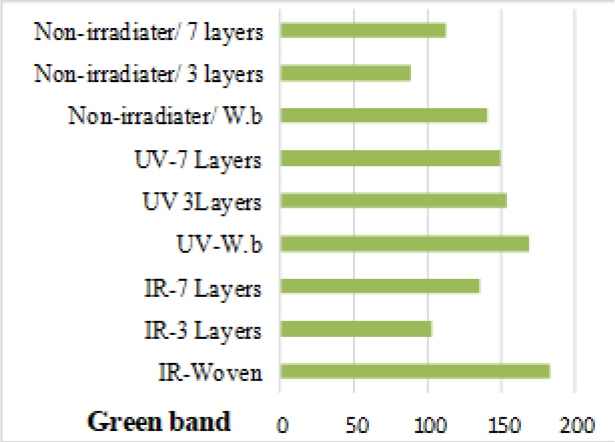

Fig. 3. Relationship between green band and different conditions of cowpea seeds stored day.
Source: Authors' determination.

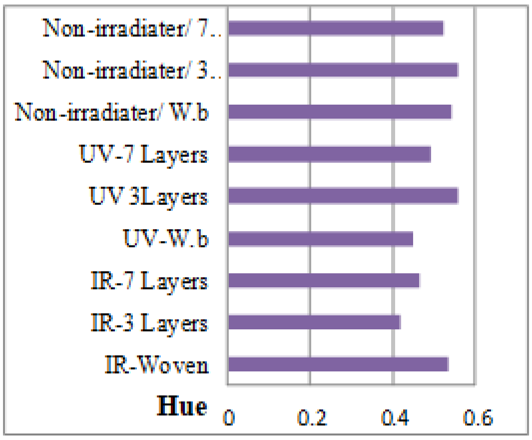

Fig. 4. Relationship between Hue and different conditions of cowpea seeds stored day.
Source: Authors' determination.

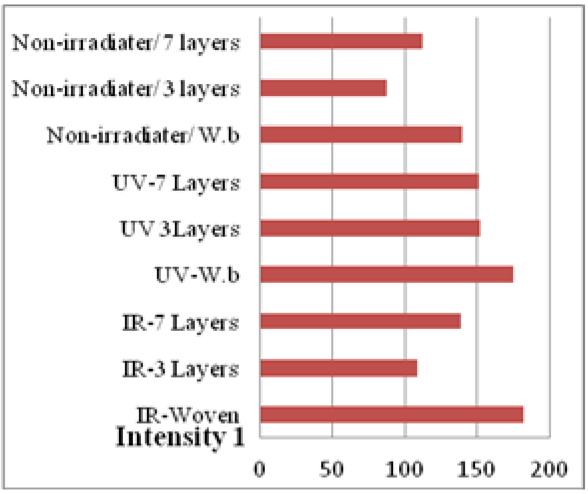

Fig. 5. Relationship between Intensity1 and different conditions of cowpea seeds stored day.
Source: Authors' determination.

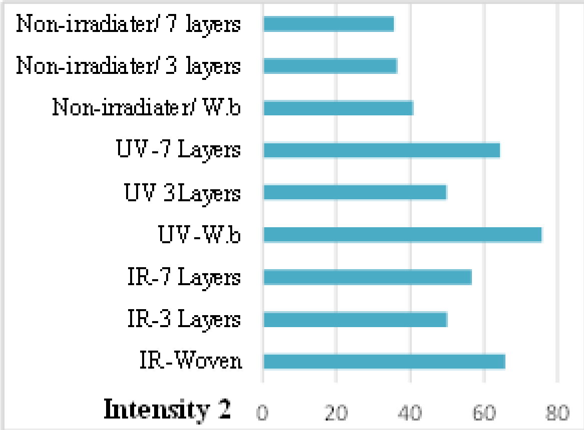

Fig. 6. Relationship between Intensity 2 and different conditions of cowpea seeds stored day.
Source: Authors' determination.

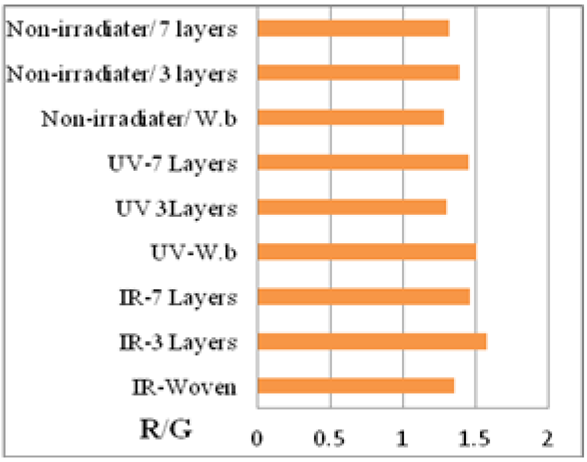

Fig. 7. Relationship between R/G and different conditions of cowpea seeds stored day.
Source: Authors' determination.

CONCLUSIONS

The application of infrared heating of legumes (Cowpea seeds) is gaining importance due to its inherent advantages over conventional heating. Pre-treatment with infra-red of cowpea seeds or ultra-violet radiation and storage of cowpea seeds in hermetic bags (three or seven layers) showed a safe storage result in terms of seeds quality and prevention of microorganisms and insect growth at the FIR and UVC optimum conditions.

When using infra-red pre-treatment for cowpea seeds, the irradiation intensity of 882.67 w/m^2 at exposure time of 15 min get total microbial count 2.3 log cfu/g., and moisture content 8.13 % of cowpea seeds.

When using ultra-violet pre-treatment for cowpea seeds, the irradiation intensity of

3.538 mw/cm^2 at exposure time of 40 min is recommended to get total microbial count 2 log cfu/g., UVC irradiation treatment does not affect the moisture content of the pre-treated cowpea seeds.

Color change for Cowpea seeds after stored effect by FIR and UVC irradiation intensity and hermetic bags (three & seven layers), the differences in Red color band increased by 60.6% when using the seeds that irradiated with UVC radiation and stored in woven bag, the differences in green color band increased by 61.8% when using the seeds that irradiated with FIR radiation and stored in woven bag , the differences in blue color band increased by 65.5% when using the seeds that irradiated with FIR radiation and stored in woven bag , the differences in Hue increased by 7.14% when using the seeds that irradiated with UVC and stored in three layers bag, the differences in intensity I_1 increased by 61.6% when using the seeds that irradiated with FIR and stored in woven bag, the differences in intensity I_2 increased by 60.4% when using the seeds that irradiated with UVC radiation and stored in woven bag and the differences in R/G increased by 9.5% when using in the seeds that irradiated with FIR radiation and stored in three layers bag.

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