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Effects of Shrink Film Wrapping and Irradiation on Storage Quality of Leconte Pears (*Pyrus communis* L.)

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Abstract: The effects of individual fruit wrapping with polyolefin shrink film (POF) and irradiation with gamma ray using CO^{60} source at 0, 0.5, 0.75 and 1.00 K.Gy on quality of LeConte pears (*Pyrus communis* L.) stored at 0±1°C with relative humidity (RH) 85 – 90% followed by holding under market conditions at (20±2°C, RH 85 – 90 %) were studied. Fruit characters included weight loss %(WL%), discarded fruits %, fruit pulp texture (Kg/f), soluble solids content (SSC ºBrix), total titratable acidity and respiration rate. Fruits individually wrapped in polyolefin shrink film in combined with irradiation at 0.75 greatly decreased WL% and discarded fruits % when comparing to any treatment else, vice versa wrapping fruit and irradiated with 1.0 K.Gy and control treatment. In addition, fruits wrapped and irradiated at 0.75K.Gy softened more slowly than other treatments with advanced in cold storage durations, allowing more additional market conditions. Fruits were treated with (POF) wrapping and (POF) wrapping plus irradiation at 0.75 K.Gy exhibited the highest content of SSC in most of the storage durations, with no significant differences between them. Whereas, the least significant value was obtained by wrapped fruit with or without irradiated at 0.50 K.Gy. All evaluated treatments succeeded in reducing respiration rate of "Le Cont" pear fruits during storage durations in comparison with the control treatment. Whereas, fruits wrapped in POF wrapping and irradiation at 0.5 or 0.75 K.Gy proved to be the most efficient treatment in this concern.

Key words: Pears fruit · Polyolefin shrink film wrapping (POF) · Gamma ray irradiation · Cold storage

INTRODUCTION

Le Conte pear is one of the most important deciduous fruit that shows great success and is widespread in the newly reclaimed areas in Egypt [1-4]. Moreover, it has good dessert quality and reported better fire blight resistance and to its storage behavior [5-7]. Individual shrink-wrap packaging is a new technique for post harvest handling of fruit and vegetables. A few studies have standardized this novel technique for various fruits like peach, guava and apple [8-10]. The Individual shrink-wrap packaging extends the marketing life by preventing the maintaining firmness and reducing the respiration rate. It also delays the physiological deterioration of fruit sometime even better than the low temperature storage. In general, 10-20% reduction in transpiration rate is possible by individual shrink-wrap packaging under ambient condition. Such unit pack provides protection against a abrasion and maintains an attractive appearance of the produce It avoids condensation of droplets within the package. One of the biggest advantages of individual shrink-wrap packaging is that it prevents secondary infection, which is important for long-term storage. Individual fruit wrapping also provide the optimum gas and humidity condition for maintaining the quality during transit and storage. As a result, it doubles or at times triples the shelf life of fruits and vegetable without any refrigeration. The extent of benefit from shrink-wrap packaging depends upon the type of produce, its physiological maturity and initial quality. Fruits having large surface to volume ratio are particularly more susceptible to water loss and this technique has been found to be a boon for extending storage life of such produce [9-11].

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Due to its price, high quality and environmental friendliness, polyolefin shrink film (POF) film is replacing other heat shrinkable film (e.g. PVC heat shrinkable film) [12]. Moreover, it has several applications, due to excellent features of POF film, 25 micron thick PO film can be the replacement of 35-50 micron thick PVC film, thin & tenacious with even thickness soft and optimal humidity-resistant. High tensible and tear-resistant strength shrink rate can be easy adjusted. In addition, it has optimal cold resistance ever at -50°C, does not goes hardened, can easy and suitable used in frozen package. Packed product free of deformation in long time preservation, non-toxic, no toxic gassed are produce in heat-seal process, it accord with American standard of FDA and USDA [13]. Many studies have been carried out in order to develop preservation methods. Among the methods tested, gamma irradiation has proved to be effective in reducing bacterial and mold contamination as well as delaying the ripening of climacteric fruits [14]. Earlier study of Wani *et al*. [15] revealed that, a gamma-ray dose of 1.5–1.7 K.Gy was effective in extending the shelf life by 2 weeks for ambient storage of the fruit. Combinatory treatments have also widely been investigated as they often result in synergistic effects. Gamma-irradiation in combination with other treatments (e.g., heat, washing, waxing) decreased the microbial contamination level leading thus to an improvement of the shelf life [16, 17]. Other reports revealed that pear could in general tolerate a dose of around 1 K.Gy. Bartlett pears irradiated within 1.0 and 2.0 K.Gy resulted in a delay in ripening by 2 days, while irradiation with 3 and 4 K.Gy resulted in abnormal ripening [18]. Sattar *et al*. [19] reported that LeConte pear could be successfully irradiated when it is slightly unripe and with a dose of 2–3 K.Gy, ripening could be delayed by 2–3 days.

Quality change during post-harvest was investigated through the effect of gamma-irradiation alone and in combination with polyolefin shrink film was investigated with respect to extension storage cold and market conditions of "Le Conte" pear.

MATERIALS AND METHODS

This investigation was carried out during 2010 and 2011 seasons to improve fruit quality of Le Conte pear fruits (*Pyrus communis*, L.) as affected by POF shrink wrapping film and irradiation. Pear fruits were harvested from a private orchard located in Bilbeis, Sharqia Governorate, from 7 years old trees planted at 4×4 meters apart grown in sandy soil and irrigated with drip irrigation system. Cultural practices were done according to general field recommendations including fertilization, pruning, as well as pest diseases control. Pears fruits were picked in early morning hard green mature stage according to suitable maturity indices to pear fruit utilize a combined flesh firmness & soluble solids content (SSC) index that is further modified by fruit size and skin color (if yellowish green, no firmness or SSC limits) [20, 11]. Healthy fruits free from any physiological and pathological disorders were chosen. Moreover, the uniformity of fruits shape and size were observed. Fruits harvested at early morning and directly transferred to the National Center for Radiation Research and Technology (NCRRT) located in Nasr City, Cairo, Egypt. The fruits were washed with tap water containing Clorox 1 % (0.05% Sodium hypochlorite) and air dried, then divided into 8 groups (45 fruits/treatment, with 15 fruits/replicates) and treated with the following treatments:

POF Shrink Film Individual Wrapping Treatment: Fruits were individually wrapped in polyolefin shrink film (POF) thickness 25ì &specific density 0.922 & weight per square meter 23.05g & area per kilogram 43.38m^2 according to Soroka [12] and Yam [13] in two steps:

- Shrink wrapping machine Smipack T 450.
- Under vacuum sealing machine FP 560A.

Irradiation Treatments: The irradiation facility looked place (NCRRT) in the Egypt Industrial Mega Gamma-(.Model "AECI, JS" where the irradiator is provided with two automatic conveyer. The principal conveyer being devoted for radiation sterilization of medical products, whereas, the auxiliary conveyor is used for pilot scale irradiation. The irradiation sources was CO^{60} and average dose rate was 0.15 Gy /sec. in dimension, were utilized in this irradiation process. For both seasons four low doses irradiation have been done which were 0.0, 0.5, 0.75 and 1.00 K.Gy of each was represented by one group of fruit.

The Used Treatments Were:

- Control (No irradiating and no wrapping)
- Fruit wrapping individual with polyolefin shrink film
- Fruit irradiating with 0.50 K.Gy with no wrapping
- Fruit irradiating with 0.75 K.Gy with no wrapping
- Fruit irradiating with 1.00 K.Gy with no wrapping
- Fruit irradiating with 0.50 K.Gy with wrapping individual with polyolefin shrink film
- Fruit irradiating with 0.75 K.Gy with wrapping individual with polyolefin shrink film

- Fruit irradiating with 1.00 K.Gy with wrapping individual with polyolefin shrink film

All treated fruits were packed in export carton boxes "42×28×12 cm.", each treatment was replicated three times. Fruits stored at 0±1°C with 85±5 % RH in the cold store for 45 days subsequent 10 days representing market conditions at 20± 2°C.

A sample of randomly selected fruits at the beginning of cold storage duration (0 day) and bimonthly (15 days) intervals was taken from each replication for all treatments during the storage period and 5 days during market conditions 20± 2 °C. Data on the following parameters was recorded:

Physical Properties

Discarded Fruits Percentage: On each sampling date, any fruit that began to suffer from any physiological disorder or pathological symptoms that affected its appearance and loss on its marketability was discarded. The number of discarded fruits relative to the initial number of fruits per each box was estimated and discarded fruits % were calculated.

Weight Loss Percentage: Fruits were weighed periodically and loss in fruits weight was recoded for each replicate.

Fruit Texture (kgf): By peeling the two opposite sides of the fruits away of the suture and the texture of each side was determined by using a Mangness – taylor type pressure tester.

Chemical Constituants

Soluble Solide Contents SSC (°Brix): By using General Purpose Automatic Refractometer (Index instruments GPR 11-37 Refractometer). Using drops of extracted juice from homogenized pulp filtrated using what man No.1 filter paper, by calibrating temperature at 20°C [21].

Titratable Acidity (T.A%): It was expressed as percentage of citric acid (g citric acid/100 fresh pulp weight), by using phenol phathalin indicator according to the Official Methods of Analysis A.O.A.C [21].

Respiration Rate (CO_2mg / kg. fruit hr.): Carbon dioxide produced by pear fruits was determined after 10 hrs finished from treatments and then every 15 days during cold storage and 5 days the subsequent storage at 20±2°C. until experiment termination periodically. The air –flow was passed through concentrated NaOH, to insure that air-flow is CO_2 free, before passing into 1-liter jar fruit container (fruit ambient) one fruit/ jar was considered one replicate. The out –coming air-flow was then passed into 100 ml. NaOH of 0.1 N for 1 hr. Such solution was then titrated against 0.1 N HCl and CO_2 levels produced by the fruits were then calculated as mg CO_2/kg fruits/h and [22].

Statistical Analysis: Data was analyzed by using MSTAT-C software (MSTAT, Michigan University East Lansing). Analysis of variance (ANOVA) and Duncan multiple significant difference (LSR) was performed to determine any significant difference among various treatments at 5% level of probability according to Sendecor and Cochran [23].

RESULTS AND DISCUSSION

Physical Properties

Weight Loss Percentage: From data in Table 1 it is clear that, fruits weight loss (WL) steadily increased with advanced in cold storage durations and storage under market condition. Wrapping treatment scored the lowest WL %. Whereas, irradiated fruits recorded the highest WL% compared with wrapping treatments and control. The rate of weight loss was faster at irradiation treatment compared with wrapping one Fruits were wrapped individually in polyolefin shrink film in combined with irradiation at 0.75 decreased WL% when compared to any treatment else, vise versa fruit treated with wrapping plus 1.0 K.Gy and control treatment. The reduction of WL% wrapped mangoes could be due to prevention of excessive moisture loss and a slow rate of respiration [11, 24]. The reduction of WL % by irradiation are also reported by Wani *et al*. [15]; Wani *et al*. [4] and Perez *et al*. [25].

Discarded Fruits (%): Table 2 illustrated that, till 15 days from cold storage, there weren't any discarded fruits observed by treatments except for treatments of irradiation at 1.0 K.Gy in combined with wrapping treatment. At the end of cold storage and market conditions treatments wrapping in combined with of irradiation at 0.50 K.Gy or 0.75 K.Gy, exhibited the least significant discarded fruits. Whereas, the highest score values of discarded fruits the end of cold storage duration were recorded by fruit treated with wrapping and1.0 K.Gy. According to Spalding and Reeder [16] ; Prakash *et al*. [26]; Wani *et al*. [15] and Perez *et al*. [25] high ripening heterogeneity was observed in control and irradiated pears along cold and shelf storage.

Table 1: Effects of film wrapping and gamma – irradiation on weight loss percentage of pear fruits during cold storage at 0±1°C and under market conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)			Days in market conditions (20 ±2°)C	
Treatments	15	30	45	5	10
			Season 2010		
Control	1.85 a	3.02 a	3.84 a	4.70 a	5.31 a
POF	0.78 c	1.14 c	1.62 c	2.04 c	2.59 cd
0.50 K.Gy	1.53 ab	2.07 b	2.83 b	3.13 b	3.92 b
0.75 K.Gy	1.69 a	2.00 b	2.66 b	2.89 b	3.57 bc
1.0 K.Gy	1.82 a	2.72 ab	3.11 b	3.57 b	3.86 b
POF + 0.50 K.Gy	0.71 c	0.94 c	1.31 c	1.91 c	2.36 cd
POF + 0.75 K.Gy	0.87 c	1.07 c	1.40 c	1.87 c	2.11 d
POF + 1.0 K.Gy	1.38 b	2.98 a	4.19 a	4.68 a	5.71 a
			Season 2011		
Control	1.71 a	2.96 a	3.25 a	4.15 a	5.08 a
POF	0.86 cd	1.05 d	1.53 c	2.11 c	2.32 cd
0.50 K.Gy	1.67 ab	1.95 c	2.74 b	3.20 b	3.81 b
0.75 K.Gy	1.75 a	2.36 bc	2.71 b	3.33 b	3.66 b
1.0 K.Gy	2.11 a	2.64 ab	2.96 ab	3.64 ab	3.90 b
POF + 0.50 K.Gy	0.69 d	1.11 d	1.61 c	1.87 c	2.68 c
POF + 0.75 K.Gy	0.93 cd	1.36 d	1.84 c	2.06 c	2.03 d
POF + 1.0 K.Gy	1.25 bc	2.57ab	3.20 a	4.31 a	4.95 a

Values in each column followed by the same letter (s) are not significantly different at 5% level

POF : Fruit wrapped individually with polyolefin shrink film

Control. : Untreated and unwrapped fruits

Table 2: Effects of film wrapping and gamma - irradiation on discarded fruits percentage of Pear fruits during cold storage at 0±1°C and under market conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)			Days in market conditions (20 ±2°)C	
Treatments	15	30	45	5	10
			Season 2010		
Control	0.0 b	8.89 a	13.33 b	20.0 b	26.67 ab
POF	0.0 b	0.0 b	0.0 c	0.0 d	4.44 d
0.50 K.Gy	0.0 b	2.22 b	4.44 bc	8.89 c	11.11 c
0.75 K.Gy	0.0 b	0.0 b	2.22 c	6.67 cd	13.33 c
1.0 K.Gy	0.0 b	4.44 b	6.67 b	15.56 b	22.22 b
POF + 0.50 K.Gy	0.0 b	0.0 b	0.0 c	4.44 cd	8.89 cd
POF + 0.75 K.Gy	0.0 b	0.0 b	0.0 c	2.22 d	4.44 d
POF + 1.0 K.Gy	6.67 a	13.36 a	20.0 a	28.89 a	33.34 a
			Season 2011		
Control	0.0 a	6.67 a	13.33 a	22.22 a	31.11 a
POF	0.0 a	0.0 b	0.0 c	0.0 d	2.22 c
0.50 K.Gy	0.0 a	0.0 b	0.0 c	6.67 cd	8.89 b
0.75 K.Gy	0.0 a	0.0 b	6.67 b	11.11 b	15.56 b
1.0 K.Gy	0.0 a	2.22 b	11.11 b	17.17 ab	26.67 a
POF + 0.50 K.Gy	0.0 a	0.0 b	0.0 c	4.44 cd	8.89 b
POF + 0.75 K.Gy	0.0 a	0.0 b	0.0 c	0.0 d	4.44 c
POF + 1.0 K.Gy	0.0 a	6.67 a	11.11 b	15.56 ab	26.67 a

Values in each column followed by the same letter (s) are not significantly different at 5% level

POF : Fruit wrapped with polyolefin shrink film

Control. : Untreated and unwrapped fruits

Table 3: Effects of film wrapping and gamma irradiation on Fruit texture (Kgf) of Pear fruits during cold storage at 0±1°C and under market conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)				Days in market conditions (20 ±2°)C	
Treatments	0	15	30	45	5	10
			Season 2010			
Control	6.7 a	6.5 a	4.9 c	3.2 d	1.7 d	1.06 cd
POF	6.6 a	6.3 a	5.7 ab	5.3 a	4.0 ab	3.5 a
0.50 K.Gy	6.4 a	6.3 a	5.9 a	4.4 bc	3.3 bc	2.9 b
0.75 K.Gy	6.3 a	6.4 a	5.7 ab	4.8 ab	3.6 b	3.2 ab
1.0 K.Gy	6.3 a	6.2 a	5.4 bc	3.7 c	2.8 c	2.0 c
POF + 0.50 K.Gy	6.4 a	6.2 a	5.8 ab	5.0 ab	4.2 a	3.3 ab
POF + 0.75 K.Gy	6.6 a	6.3 a	6.0 a	5.5 a	4.7 a	3.7 a
POF + 1.0 K.Gy	6.5 a	6.0 a	5.1 c	3.1 d	1.5 d	0.97 d
			Season 2011			
Control	6.8 a	6.5 a	4.5 d	2.8 d	1.5 d	1.00d
POF	7.2 a	6.8 a	6.0 a	5.5 a	4.6 a	3.9 a
0.50 K.Gy	6.7 a	6.5 a	5.1 c	4.1 c	3.5 b	2.6 b
0.75 K.Gy	6.8 a	6.7 a	5.8 ab	5.0 b	3.8 b	3.00 b
1.0 K.Gy	7.0 a	6.7 a	5.6 ab	3.9 c	2.5 c	1.85c
POF + 0.50 K.Gy	6.9 a	6.6 a	5.4 bc	4.8 b	3.9 b	3.1 b
POF + 0.75 K.Gy	7.0 a	6.7 a	6.1 a	5.7 a	4.4 a	4.0 a
POF + 1.0 K.Gy	7.2 a	6.5 a	4.9 cd	3.6 c	1.6 d	1.21 d

Values in each column followed by the same letter (s) are no t significantly different at 5% level

POF : Fruit wrapped individually in polyolefin shrink film

Control. : Untreated and unwrapped fruits

Table 4: Effects of film wrapping and gamma - irradiation on total soluble solid of Pear fruits during cold storage at 0±1°C and under market conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)				Days in market conditions (20 ±2°)C	
Treatments	0	15	30	45	5	10
			Season 2010			
Control	12.3 a	12.6 a	13.0 a	12.6 c	11.7 c	11.2 c
POF	12.5 a	12.7 a	13.4 a	14.5 a	15.1 a	16.30 a
0.50 K.Gy	12.5 a	12.5 a	13.2 a	13.4 bc	14.8 ab	15.2 b
0.75 K.Gy	12.6 a	12.8 a	13.4 a	13.6 b	14.1 b	15.5 ab
1.0 K.Gy	12.4 a	12.8 a	13.6 a	14.2 ab	14.3 b	14.6 b
POF + 0.50 K.Gy	12.5 a	12.6 a	12.9 a	13.4 bc	14.8 ab	15.7 ab
POF + 0.75 K.Gy	12.4 a	12.7 a	13.6 a	14.6 a	15.3 a	16.4 a
POF + 1.0 K.Gy	12.4 a	12.6 a	12.9 a	12.4 c	11.2 c	10.6 c
			Season 2011			
Control	11.8 a	12.3 a	13.3 a	13.3 d	11.5 d	10.8 d
POF	12.1 a	12.6 a	13.0 a	13.9 ab	14.4 ab	15.8 a
0.50 K.Gy	12.1 a	12.3 a	13.2 a	13.7 ab	14.6 ab	14.9 b
0.75 K.Gy	11.7 a	12.5 a	12.9 a	13.6 ab	14.3 b	15.3 ab
1.0 K.Gy	11.9 a	12.5 a	12.8 a	13.0 c	13.0 c	13.2 c
POF + 0.50 K.Gy	12.0 a	12.6 a	12.9 a	13.6 ab	14.1 b	14.7 b
POF + 0.75 K.Gy	11.8 a	12.3 a	13.1 a	14.2 a	15.1 a	16.0 a
POF + 1.0 K.Gy	11.8 a	12.4 a	13.2 a	12.7 c	11.8 d	11.0 d

Values in each column followed by the same letter (s) are not significantly different at 5% level

POF : Fruit wrapped individually in polyolefin shrink film

Control. : Untreated and unwrapped fruits

Table 5: Effects of film wrapping and gamma - irradiation on titratable acidity of Pear fruits during cold storage at 0±1°C and under conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)				Days in market conditions (20 ±2°)C	
Treatments	0	15	30	45	5	10
			Season 2010			
Control	0.32 a	0.30 a	0.31 a	0.33 a	0.33 a	0.34 a
POF	0.34 a	0.29 a	0.27 a	0.23 c	0.18 c	0.18 c
0.50 K.Gy	0.33 a	0.30 a	0.27 a	0.26 b	0.23 bc	0.21 bc
0.75 K.Gy	0.35 a	0.32 a	0.30 a	0.28 ab	0.27 b	0.24 b
1.0 K.Gy	0.33 a	0.30 a	0.29 a	0.29 ab	0.26 b	0.25 b
POF + 0.50 K.Gy	0.32 a	0.31 a	0.28 a	0.25 bc	0.24 bc	0.21 bc
POF + 0.75 K.Gy	0.32 a	0.28 a	0.26 a	0.20 c	0.20 c	0.19 c
POF + 1.0 K.Gy	0.33 a	0.30 a	0.29 a	0.31 a	0.35 a	0.37 a
			Season 2011			
Control	0.37 a	0.32 a	0.29 a	0.27 ab	0.30 a	0.31 a
POF	0.38 a	0.33 a	0.28 a	0.25 b	0.23 bc	0.21 c
0.50 K.Gy	0.35 a	0.32 a	0.27 a	0.25 b	0.23 bc	0.20 c
0.75 K.Gy	0.37 a	0.31 a	0.29 a	0.24 bc	0.21 bc	0.19 c
1.0 K.Gy	0.37 a	0.33 a	0.27 a	0.26 ab	0.25 b	0.27 b
POF + 0.50 K.Gy	0.39 a	0.33 a	0.26 a	0.24 bc	0.23 bc	0.22 c
POF + 0.75 K.Gy	0.36 a	0.34 a	0.26 a	0.21 c	0.19 c	0.18 c
POF + 1.0 K.Gy	0.35 a	0.34 a	0.27 a	0.29 a	0.30 a	0.32 a

Values in each column followed by the same letter (s) are not significantly different at 5% level

POF : Fruit wrapped individually in polyolefin shrink film

Control. : Untreated and unwrapped fruits

Table 6: Effects of film wrapping and gamma - irradiation on Respiration rate (mgCO2/kgfruit/hr) of Pear fruits during cold storage at 0±1°C and under conditions at 20±2°C during 2010 and 2011 seasons

	Days in cold storage (0 ±1°C)				Days in market conditions (20 ±2°)C	
Treatments	0	15	30	45	5	10
			Season 2010			
Control	18.13 a	6.60 a	7.24 a	9.73 a	20.31 a	26.5 a
POF	17.50 a	5.20 b	4.92 c	4.33 c	12.15 d	14.10 d
0.50 K.Gy	16.63 a	7.10 a	6.18 b	6.12 b	15.11 bc	17.9 bc
0.75 K.Gy	16.73 a	6. 71 a	6.20 b	6.80 b	15.78 bc	18.16 bc
1.0 K.Gy	18.74 a	7.11 a	6.43 ab	6.65 b	17.60 ab	20.30 b
POF + 0.50 K.Gy	16.76 a	6.17 ab	5.80 bc	5.42 bc	14.20 cd	15.5 cd
POF + 0.75 K.Gy	17.58 a	5.37 b	4.63 c	4.17 c	11.95 d	14.37 d
POF + 1.0 K.Gy	17.90 a	6.28 ab	6.13 b	8.60 a	19.58 a	23.7 a
			Season 2011			
Control	17.13 a	7.39 a	6.81 a	10.10 a	18.53 a	24.30 a
POF	17.56 a	5.16 bc	4.40 c	4.64 d	10.87 d	15.24 cd
0.50 K.Gy	17.14 a	7.10 a	7.47 a	7.58 c	14.97 c	16.11 c
0.75 K.Gy	17.50 a	7.43 a	7.11 a	7.23 c	14.20 c	16.98 c
1.0 K.Gy	18.26 a	6.99 a	7.36 a	8.53 b	16.36 b	19.23 b
POF + 0.50 K.Gy	16.93 a	5.86 b	5.36 b	5.11 d	10.27 d	14.78 cd
POF + 0.75 K.Gy	17.34 a	5.08 c	4.36 bc	4.70 d	9.14 d	13.8 d
POF + 1.0 K.Gy	17.61 a	6.08 b	7.65 a	9.11 ab	17.14ab	21.91 a

Values in each column followed by the same letter (s) are not significantly different at 5% level

POF : Fruit wrapped individually in polyolefin shrink film

Control. : Untreated and unwrapped fruits

Fruit Texture (Kgf): Data in Tables 3 shows the changes in (Le Conte) pear fruits texture in cold storage and storage under market conditions decrease with doses from 0.0 to 0.1 K.Gy. However, fruits wrapped and irradiated at 0.75 K.Gy softened more slowly than any other treatments with shelf storage, allowing additional shelf-life No differences in texture were found between control and irradiated pears at 1.0 K.Gy after cold plus shelf storage. All irradiated pears showed appropriate exportation pulp texture after cold and shelf storage. Drake *et al*. [27] found that 'Anjou' pears did not lose firmness, whereas 'Bosc' pears lost firmness at doses from 600 to 900 Gy. 'Bosc' pears exposed to 900 Gy softened more slowly compared to those treated with lower doses. Plastic film was found to be advantageous in cutting down the respiration rate and increasing shelf life of mango [24]. In addition, Yamashity *et al*. [28] added that sealing individual climacteric fruits in low density polyethylene bags delayed ripening and softening and hence improved marketability.

Fruit Chemical Analysis

Soluble Solide Contents SSC (°Brix): Data in Table 4 illustrated that, the longer the cold storage or market storage periods the higher SSC contents in both seasons regardless of the used treatments. pears is a climacteric fruits that tend to have increased SSC until maximum is reached at the fully ripe stage, followed by a decreasing trend when the fruits reaches full senescence [3, 7, 29]. Fruits were treated with POF wrapping and POF wrapping and irradiation at 0.75 K.Gy exhibited the highest content of SSC in most of the storage durations, with no significant differences between them. On the other hand the least contents of SSC were obtained by treatments of control and fruits were treated with irradiation at 1.0 K.Gy. Drake *et al*. [27] and Chen and Spotts [30] reported that TA of 'Anjou' and 'Bosc' pears was not affected by irradiation.

Titratable Acidity (T.A%): From table 5, its clear that Titratable acidity value proportionally decreased with the progress in cold storage and under contains. Significant differences began to appear at the end of cold storage. The highest value was obtained with treatments of control and treated fruits were irradiation at 1.0 k. On the other hand the least value was obtained by wrapped fruit with or without with irradiated at 0.75 K.Gy. Maturity of 'Packham's Triumph' pears, represented by the coefficient SSC/TA, was slightly affected by irradiation and tended to increase with cold and shelf storage. No differences were observed between control and irradiated pears after shelf storage [6, 25, 31]. Changes in TA and pH are based on changes in citric, malic and ascorbic acid, concentrations of those acids are known to diminish during pears ripening [11]. This finding could be associated with the higher rate of respiration substrate for catabolic process in pears. Maturity of 'Packham's Triumph' pears, represented by the coefficient SSC/TA, was slightly affected by irradiation and tended to increase with cold and storage at 20°C [25].

Respiration rate (mg CO_2/kg fruit/hr): Results of table 6 shows that, all evaluated treatments succeeded in reducing respiration rate of "LeCont" pear fruits during storage durations in comparison with the control treatment. Whereas, Fruits wrapped in POF wrapping and irradiation at 0.5 or 0.75 K.Gy proved to be the most efficient treatment in this concern.

On the other hand, the highest respiration rate were obtained by treatments of control descendible by fruits were wrapped in POF in combined with irradiation at 1.0 K.Gy. retards ageing through reduced respiration rate and other undesirable metabolic catalysis and led to a chemical and biochemical breakdown in fruits and vegetable [32]. These results are in a confirms with the earlier reports investigated by d'Amour *et al*. [33] and Drake *et al*. [27]. Concerning the effect of wrapping in sealed film Kader [14] reported that the role of modified atmosphere packaging (MAP) was primarily to reduce the respiration rate of fruits and vegetable by retarding metabolic activities. Reducing respiration also retards softening and slowdown various compositional changes associated with repining. This result confirms the findings of Drake *et al.* [27]; Wani *et al*. [15];Wani *et al*. [4] and Perez *et al*. [25].

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