Effects of Packaging Films on the Quality and Storage Stability of Cheese Shake Biscuits made from Germinated Hom Nin Brown Rice Flour with Sugar-reduced Pineapple Paste Filling

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บทคัดย่อ

บิสกิตชีสเชคที่ผลิตจากแป้งข้าวกล้องหอมนิลงอกไส้สับปะรดกวนลดน้ำตาลบรรจุในถุง polypropylene/cast polypropylene (OPP/CPP), ถุง polyethylene terephthalate/linear low density polyethylene (PET/LLDPE) และถุง laminated with multilayer metalize (MET) ถูกเก็บรักษาที่อุณหภูมิห้อง (30 องศาเซลเซียส) เป็นเวลา 2 เดือน และประเมินคุณภาพทุกๆ 1 เดือน ผลิตภัณฑ์ถูกนำไปวิเคราะห์คุณสมบัติทางกายภาพ เคมี จุลินทรีย์ และประสาทสัมผัส ผลการวิเคราะห์พบว่า เวลาในการเก็บรักษามีผลอย่างมีนัยสำคัญทางสถิติต่อคุณสมบัติทางกายกาพภาพ (วอเตอร์แอคติวิตี้ และค่าความแข็ง) และเคมี (ค่าเพอร์ออกไซด์) ในขณะที่ชนิดของบรรจุภัณฑ์ไม่มีผลอย่างมีนัยสำคัญทางสถิติ บิสกิตชีสเชคที่บรรจุในถุง OPP/CPP ถุง PET/LLDPE และถุง MET มีค่าความแข็งเพิ่มสูงขึ้นร้อยละ 39, 21 และ 28 ตามลำดับหลังการเก็บรักษาเป็นเวลา 2 เดือน ยิ่งไปกว่านั้นค่าความเป็นกรดและค่าเพอร์ออกไซด์เพิ่มขึ้นอย่างรวดเร็วในช่วงระยะเวลา 2 เดือนของการเก็บรักษา จากการทดสอบทางประสาทสัมผัสเชิงพรรณนา แสดงให้เห็นว่า บรรจุภัณฑ์ที่ต่างชนิดกันไม่ส่งผลให้เกิดความแตกต่างของคะแนนในด้านสี, กลิ่นและความหวานของบิสกิตชีสเชค อย่างไรก็ตามค่าคะแนนความกรอบของผลิตภัณฑ์ลดลงเมื่อเก็บรักษาไว้นานขึ้น ถุง PET/LLDPE และถุง MET สามารถรักษาความกรอบของบิสกิตชีสเชคได้ดีกว่าถุง OPP/CPP ปริมาณจุลินทรีย์ทั้งหมด ยีสต์และรา ของบิสกิตชีสเชคที่บรรจุในชนิดถุงที่แตกต่างกันมีค่าน้อยกว่า 10 โคโลนีต่อกรัมในระหว่างการเก็บรักษาเป็นเวลา 2 เดือนซึ่งอยู่ภายใต้มาตราฐาน มอก.

คำสำคัญ: แป้งข้าวกล้องหอมนิลงอก บิสกิตชีสเชค บรรจุภัณฑ์ การเก็บรักษา

Abstract

Cheese shake biscuits were made from germinated hom nin brown rice flour with sugar-reduced pineapple paste filling (GHNBP) and packed in polypropylene/cast polypropylene (OPP/CPP), polyethylene terephthalate/linear low density polyethylene (PET/LLDPE), and laminated multilayer metalize (MET) pouches. The biscuits were stored at an ambient temperature (30ºC) for 2 months and quality evaluations were done at one month intervals. The products were analyzed for physical, chemical, biological, and sensory characteristics. The physical (water activity and hardness) and chemical (acid value and peroxide value) properties were significantly affected by the storage time but not significantly affected by the type of packaging materials. The biscuits packed in OPP/CPP, PET/LLDPE, and MET pouches showed increases in hardness value after two months by 39, 21 and 28% respectively. Moreover, the acid and peroxide values increased rapidly after two months of storage. The quantitative descriptive analysis revealed no differences in the scores awarded for color, odor, and sweetness of GHNBP packed in various pouches but the crispiness decreased with storage time. PET/LLDPE and MET pouches were better in the preservation of the crispness compared to OPP/CPP. Total plate counts as well as yeast and mold counts of the biscuits packed in different pouches were less than 10 cfu/g during the two months and were considered to meet the standard.

Keywords: Germinated hom nin brown rice flour: Biscuits: Packaging films: Storage study

Introduction

Shelf-life stability is of great importance for the food industry to ensure that the consumer receives a high-quality product for a certain period of time. Packaging is one of the most important parameters for shelf-life [1], [2]. It is used as a barrier providing resistance to the passage of gases, vapors, and odors. Hence, the selected packaging is imperative to maintain the desired product quality during the shelf-life period.

The objectives of this study were to determine the physical, chemical, biological, and sensory properties of cheese shake biscuits made from germinated hom nin brown rice flour with sugar-reduced pineapple paste filling (GHNBP) packed in three different types of materials, polypropylene/cast polypropylene (OPP/CPP), polyethylene terephthalate/linear low density polyethylene (PET/LLDPE), and laminated multilayer metalize (MET) pouches. OPP/CPP and PET/LLDPE films were selected in this study because they provide consumers with easy access to the product quality while MET film has low permeability to water vapor and oxygen. Moreover, they are commercially available and they provide different properties of water vapor and oxygen transmission rates. Therefore, it is interesting to know what kind of packaging is suitable for this biscuit product. The storage stability was studied at an ambient temperature (30ºC) for two months to assess the product quality.

Materials and methods

Biscuits: Germinated hom nin brown rice flour (Nuttakeitkhanagritech Co., Ltd, Thailand) was used to prepare cheese shake biscuits with sugar-reduced pineapple paste filling (GHNBP)(12±3 g per piece and a_w of 0.56).

Packaging films: The product (one piece) was packed in OPP/CPP, PET/LLDPE and MET pouches (50.5 nm x 90 nm x 20 nm) (Thai Film Industries Public Co., Ltd). The barrier properties of plastic composition, water vapor transmission rate (WVTR), and oxygen transmission rate (OTR) are presented in Table 1.

Storage conditions: The products were stored at an ambient temperature (30ºC) for 2 months.

Storage stability evaluation: A 3x2 factorial arrangement in CRD with 3 packaging types (OPP/CPP, PET/LLDPE, and MET pouches) and 2 storage periods (1 and 2 months) was investigated. The texture hardness of the GHNBP was examined and expressed as an average of maximum peak force from ten independent measures using a TA-XT plus Texture Analyzer (Stable Micro System Texture Analyzer, UK). Water activity (a_w) was evaluated in triplicate using an a_w meter (Navasina, model ms1, UK). Peroxide and acid values were determined in triplicate according to the method of AOAC [3]. Total plate counts and yeast and mold counts were assessed as CFU/g [4]. *Quantitative descriptive analysis* (*QDA*) was assessed for color, crispiness, rancidity, and sweetness by 15 trained panelists.

Statistical analyses: All data were analyzed with SPSS version-19 and New Duncan's Multiple Range Test was used to compare the differences among means. Analysis of variance (ANOVA) was performed to determine the significance ($p<0.05$) of the packaging types and storage time.

Results and Discussion

The physical properties of the product, hardness and water activity (a_w) increased significantly during storage owing to the water vapor transmission rate (WVTR) and oxygen transmission rate (OTR) of the packaging. The a_w of GHNBP increased with storage time and this may have been due to the hygroscopic nature of the dried product, storage environment (temperature and relative humidity), and the nature of the packaging materials. These outcomes were in accord with the observations of Leelavathi and Rao who reported that the higher moisture of biscuits containing bran may have been due to the greater hygroscopic nature of wheat bran [5]. The packaging materials showed no significant effect on the a_w value (Table 2). Rao et al. reported that biscuits packed in laminate pouches absorbed less moisture during storage, which may have been due to the impervious nature of laminated aluminum foil to air and water vapors [6]. The product hardness demonstrated affinity to a_w as biscuits packed in OPP/CPP pouches were harder than those packed in PET/LLDPE and MET pouches because they absorbed moisture and oxygen transmitted from outside to inside the package.

Acid and peroxide values of GHNBP were significantly influenced by storage as well as packaging materials. The GHNBP packed in OPP/CPP pouches had significantly higher values of acid and peroxide than those packed in PET/LLDPE and MET pouches, as shown in Table 2. The aluminum laminates protected biscuits against light, a catalyst for oxidation [7]. The noteworthy increases in acid and peroxide values during two months may have been due to increases in moisture content during storage which promoted fat hydrolysis [8].However, the result of sensory evaluation indicated that increases in the acid and peroxide values of GHNBP during storage time did not cause an increase in the rancid odor detected by the panel under the conditions of short-term storage (Figure 1b).

Regarding microbial analysis, according to Thai industrial standard of biscuits (Standard no. 523/2547) [9], total bacterial counts/g and yeasts and molds should not be more than 10^4 and 10 CFU/g respectively. This study indicated that GHNBP packed in OPP/CPP, PET/LLDPE and MET pouches and stored at an ambient temperature (30ºC) for 2 months had good stability as the microbial load remained within the standard. Figure 1 shows the effect of packaging and storage on sensory scores awarded to GHNBP. The crispiness of the biscuits decreased while scores for color and sweetness increased slightly with time. Moreover, rancid odor was very low and stable. The main parameters affecting sensory quality were rancid odor and crispiness. The packaging materials showed no effect on these except OPP/CPP pouches. In addition, the panelists commented that the product packed in OPP/CPP pouches was quite tough after two months.

Table 1 Barrier properties of plastic composition, water vapor transmission rate (WVTR), and oxygen transmission rate (OTR) used in the experiment

Plastic Composition	**WVTR plastic**[a] **(g/m^2/24hr.atm:38°C,90% RH)**	**OTR plastic**[a] **(cc/m^2/24 hr.atm:23°C)**
20 μ OPP/CPP	<8	<2000
12 μ PET/LLDPE	<40	<130
12 μ MET	<2	<3

[a] According to information from the plastic supplier

Table 2 Physical, chemical, and microbiological properties of GHNBP during 2 months of storage

Storage time / Properties	**0 Month**		**1 Month**			**2 Months**	
	Control	**OPP/CPP**	**PET**	**MET**	**OPP/CPP**	**PET**	**MET**
Water Activity	0.56±0.03^{1}	0.59a±0.00^{1}	0.58b±0.00^{1}	0.58b±0.00^{1}	0.63a±0.00^{2}	0.60c±0.00^{1}	0.61b±0.00^{2}
Hardness (g)	3.18±0.21^{1}	3.66a±0.50$^{1.2}$	3.39a±0.40$^{1.2}$	3.56a±0.50^{1}	4.42a±0.95^{2}	3.84a±0.70^{2}	4.06a±0.42^{2}
Acid value (mg KOH/g oil)	0.31±0.01^{1}	1.93a±0.06^{2}	1.89a±0.01^{2}	1.63b±0.03^{2}	3.53a±0.04^{3}	3.46b±0.03^{3}	3.39c±0.02^{3}
Peroxide value (meq peroxide/kg oil)	3.90±0.01^{1}	5.21a±0.06^{2}	4.85b±0.07^{2}	4.41c±0.02^{2}	12.87a±0.02^{3}	12.34b±0.04^{3}	12.14c±0.03^{3}
Total plate counts (CFU/g)	<10	<10	<10	<10	<10	<10	<10
Yeasts and molds (CFU/g)	<10	10	10	<10	10	10	<10

Abbreviations: Control = unpacked GHNBP, OPP/CPP = polypropylene/cast polypropylene pouches,

PET/LLDPE = polyethylene terephthalate/linear low density polyethylene pouches, MET = laminated multilayer metalize pouches

Values with different superscript numbers to the same packaging pouches are significantly different among sampling months ($p<0.05$)

Values with different letters to the same sampling months are significantly different among packaging pouches ($p<0.05$)

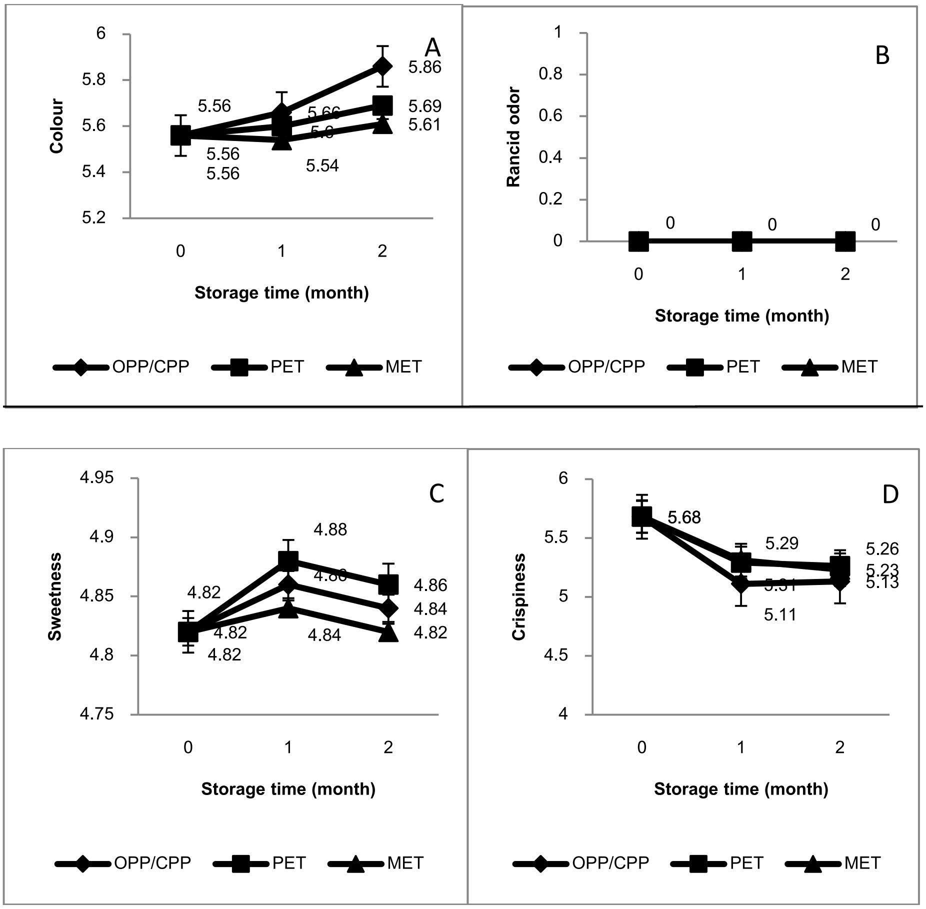

Figure 1 Sensory attributes of GHNBP on color (a), rancidity (b), sweetness (c), and crispiness (d) during 2 months of storage

Conclusion

Among the packaging films tested for product stability during storage, the PET/LLDPE and MET pouches were better than OPP/CPP in the retention of quality and acceptability. Comparisons of PET/LLDPE with MET showed that the latter is more expensive but PET/LLDPE pouches are more effective and suitable for GHNBP biscuits for at least 2 months of storage.

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