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PHYSICOFUNTIONAL PROPERTIES OF EGG POWDER AS INFLUENCED BY DRYING METHODS

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ABSTRACT

The study was carried out to determine the physical and functional properties of whole egg powder produced using four drying methods. Twenty (20) trays of freshly laid eggs were obtained from Shika brown layers at 27 weeks at lay. The eggs were alloted into four drying methods (sun, air, oven and dehydrator drying).Each 500grams of liquid egg produce a range of 122 – 125grams of egg flask which were grinded for 5min egg at a speed of 10,000Rm and sieved using a 0.5mm. A powder of 120grams was produce from each batch of 500grams of liquid and a total 1200grams of powdered eggs were obtained for each of the methods. 2 grams of each samples in a replicate of three using a complete randomize design (CRD) was collected and used for physical and functional properties of whole egg powder. The results of the study show there were significant difference across all the parameters measured except for gelation, colour absorbance and particle size The Functional properties of the powder differs ($P < 0.05$) across all the drying methods except for emulsion capacity, gelation and oil absorption stability. Dehydrator and air-dried egg powder were better than oven and sun dried egg powder in most of the physical and functional properties determined. It is concluded that egg powder can be produced using any of the process method tested but air drying gives optimize overall properties while oven drying happen to be the least among the methods. It is recommended that egg powder should be produce using air drying method.

Key: Egg powder, Drying methods, Functional, Physical and Shika brown

INTRODUCTION

Eggs from domestic fowl are basic food material that is always in demand and consumed world-wide. Eggs are effective animal proteins with a potential to contribute to food and nutrition security and generate household livelihoods (Lannotti *et al.*, 2014). Egg has a considerable place in food industry. Egg products include hard-cooked chopped eggs, precooked scrambled eggs or omelets, quiches, precooked egg patties, Scrambled egg mixes crepes (Froning, 2008) and egg powder. Comparative advantages egg powder has over fresh eggs include a longer shelf-life, easy transportation, fresh whole eggs are however, difficult to transport because of their bulkiness, fragility and highly perishable nature (Frazier and Westerhoff, 1988; Jay, 2000). At the industrial level, eggs are preserved by processing them through spray drying into egg powder (Dixit *et al.,* 2010; Kumaravel *et al.*, 2012; Rannou *et al.*, 2013). In Nigeria there is a cyclical egg glut, egg wastage and egg loses in many areas of the country, which might be on the increase as more individuals embark on poultry production in order to alleviate poverty and unemployment. In recent time several studies have been carried out on egg powder with emphases on various methods of processing and drying. The methods used are either examined on an individual bases or on particular segment of the egg. For example Adegbenro (2020), study the effects of oven drying on the nutritional properties of whole egg, egg yolk and egg albumen. Tijani (2018) studied the awareness and acceptability of oven dried whole egg powder among nursing mothers in rural areas of Ijebu North Local Government. Jay (2000) studied the influence of low moisture content in the elongation of egg powder shelf life. Most of these studies used a single drying method without comparing different methods available for egg drying. However, this study is geared toward evaluating the different drying methods for egg powder manufacture and compare the physical properties and Functional properties. The investigation stand to create awareness on valuable information to processors, farmers, researchers and consumer of egg powder. It will also provide an alternative to fresh egg for consumers and processors conveniences.

MATERIAL AND METHODS:

Study Location:

The study was carried out at the Central Advance Laboratory of Usmanu Danfodiyo University and Agriculture physical laboratory of the Faculty of Agriculture, Usmanu, Danfodiyo University Sokoto. Sokoto state is located in North-West, Nigeria, between longitude 4° and 7° E and latitude 10° and 14° N (Adeniji *et al.*, 2020). The state shares borders with Zamfara state, Kebbi state and Niger Republic. It has an altitude of about 350m above sea level and annual rainfall of about 645mm. The relative humidity ranges from 21-47% during the dry season and 51-79% during the rainy season with average minimum and maximum temperatures of 15ºc and 40ºc respectively (Aliyu *et al.*, 2022).

Experimental layout

Samples of whole egg powder representing four methods of drying (oven drying. sun drying, air drying and dehydrator drying) in three replicates were compared for physical and functional, chemical and sensory properties using a complete randomize design (CRD).

Sample preparation

One hundred and twenty (120) pieces freshly laid eggs of commercial issah layers were obtained from SD Adiya Farm in Sokoto. They were neatly unshelled and whisked thoroughly with the aid of a Sonik Japan Model, SB-1515 blender to ensure Albumen-Yolk homogenization, then the mixture was placed into a 20 litter bucket from which 500g of the egg liquid egg content was then homogenized using Rotor stator homogenizer by Auguste Gaulin 1900s for 2minutes at 5000rpm for every egg flesks that was produce from the four drying methods at intervals. The (500g) of liquid egg was spread on a 30cm x 50cm stainless tray, covered with cotton foil and put on an elevated position under the sun where it was allowed unhindered insulation and free air circulation, the eggs were stirred randomly after every one hour to ensure uniform drying and to prevent molding together under the sun until they had a crispy feel. Another 500g of liquid cv egg was spread on a tray stainless and placed in an oven for 5hours at 45 ^{0}C the egg liquid were stirred randomly after every 30min to ensure uniform drying and to prevent molding together until it had a crispy texture. Same 500g of liquid egg was spread using a dehydrator for 48 to 72 hours at temperature of 42^{0}C, the eggs were stirred randomly after every five hours to ensure uniform drying and to prevent molding together until it had a crispy texture. The last sample was air dried for 12 hours the eggs were stirred randomly after every 3hours to ensure uniform drying and to prevent molding together until it turn crispy in texture. After drying, the egg crispiest which appeared in a dried-crumbled form were grinded with a grinder for 10minute each at the speed of 10,000rpm to get the egg powder product. The whole egg powder was packed into four separate Ziploc bags labeled based on the drying methods and stored.

Data collection

Each samples of egg powder prepared was reconstituted in a ratio of 1:8 in gram of powder per grams of water. Physical properties and Functional properties were determined as describe Jibir and Sanusi *et al* (2020).

Data analyses

Results obtained were expressed as the means ± standard error of mean (SEM) and analyzed using Analysis of Variance (ANOVA). Significant difference at 5% confidence level using Tukey (Tukey, 2016).

RESULT AND DISCUSSION

Physical Properties of whole egg powder.

There were significant difference across all the parameters measured except for gelation, colour absorbance and particle size. Drying method had much effect on the physical properties of whole egg powder.

Table 1. Physical properties of whole egg powder made from four drying methods.

Physical properties	Oven dried	Sun dried	Dehydrator	Air dried	SEM
Angle of repose (^{o})	62.597^{ab}	59.287^{b}	65.507^{a}	60.220^{ab}	2.01
Tap Bulk Density (g/ml)	0.559^{b}	0.565^{ab}	0.570^{ab}	0.612^{a}	0.016
Loose Bulk Density (g/ml)	0.390^{c}	0.455^{a}	0.429^{b}	0.452^{a}	0.004
Compressibility (%)	30.278^{a}	19.049^{b}	24.762^{ab}	26.134^{ab}	2.746
Hausner ratio	0.697^{b}	0.810^{a}	0.752^{ab}	0.739^{ab}	0.027
Caking (%)	62.351^{b}	61.015^{b}	73.667^{a}	75.986^{a}	1.670
Hygroscopic (%)	3.167^{a}	2.167^{ab}	3.167^{a}	2.000^{b}	0.354
Solubility index (%)	69.124^{ab}	64.565^{ab}	57.090^{b}	81.572^{a}	6.347
Gelation (%)	32.479	29.560	98.254	59.046	27.986
Colour absorbance (nm)	491.55	439.658	437.629	412.833	93.795
Particle Size (A^o)	4.279	4.168	4.066	4.203	0.124

Oven drying (OD), Sun drying (SD), Dehydrator drying (DD) and Air drying (AD);
SEM = Standard Error of Mean
abc = Super scripts of significant or difference

Whole egg powder made from dehydrator had higher Angle of repose compared to all the other three drying methods. its agrees with the findings of Zhang et al (2008) who found that freeze dried egg powder had low angle of repose with a decreased temperature compared to oven dried egg powder which had higher angle of repose with increase in temperature. Also Kalman, (2021) reported increase in moisture content do increase the angle of repose as result of the change and increase in the shape and size of the particle which is influence by the higher moisture content trapped within the particles.

Loose bulk density, Tap bulk density, caking and solubility index was higher in egg powder made from air drying which is attributed to the air dried egg powder smooth surface area. Smooth surface area in egg powder is anticipated since no heat is involved during the air drying. The protein coagulate gentle and slowly through osmotic pressure with little compaction.

Functional properties of whole Egg powder

Table 2 shows that foaming capacity, foaming stability, Emulsifying instability and water absorption stability differs significantly ($P < 0.05$) across all the drying methods while, emulsion capacity and oil absorption stability are not significantly different ($P > 0.05$) across all the drying methods

Table 2. Effect of drying methods on functional properties of reconstituted whole egg powder

Functional property (%)	OD	SD	DD	AD	SEM
Foaming capacity	12.96^{b}	25.35^{b}	47.47^{a}	21.48^{b}	4.14
Foaming Stability	15.83^{ab}	9.85^{b}	22.50^{a}	10.55^{ab}	4.16
Emulsifying capacity	64.06	64.19	66.59	65.58	1.85
Emulsifying instability	3.50^{a}	2.67^{b}	3.60^{a}	3.44^{ab}	0.17
Oil absorption	2.60	1.80	2.18	4.06	1.21
Water Absorption	3.66^{a}	2.94^{c}	3.47^{b}	3.48^{b}	0.03

Oven drying (OD), Sun drying (SD), Dehydrator drying (DD) and Air drying (AD)
SEM = Standard Error of Mean
abc = Super scripts of significant or difference

Foaming capacity: Samples of whole egg powder made using dehydrator drying foamed more ($P < 0.05$) compared to other drying method. This may be due to the increased protein concentration which is also seen in Table 5. The relatively increase in protein concentration may be attributed to high slow and steady temperature experience with dehydrator drying that do extract moisture gently from the particles of egg powder without damaging the contents of the egg white protein which is responsible for more foaming. This finding is in line with Kalman (2021) who stated that foaming capacity increased with increase in protein concentration. Also Tekgül (2021) reported that an optimizing concentration of egg white do cause foam expansion.

Foaming Stability: Whole egg powder made from dehydrator drying method had higher foaming stability and differs ($P < 0.05$) from whole egg powder made from Sun drying method. This may be true as dehydrator method involves slow drying process and water molecules are remove in this drying method through a process called desiccation which make the water to leave the egg crystals in a more gradual and controlled manner.

Emulsifying stability: Egg powder made from dehydrator and oven-dried methods recorded the high emulsion stability ($P < 0.05$) compared to the other whole egg powder made from sun and air drying. It is expected that the higher the protein concentration the more the level of Lipoproteins and phosvitin, the more the lecithin which are well known emulsifying agent, so the compression of more protein together by oven and dehydrator drying might be responsible for the increase in protein concentration.

CONCLUSION AND RECOMMENDATIONS:

Conclusion.

From the findings of the study the following conclusions are drawn:

1. Most of the physical properties are affected by drying methods except for gelation, colour absorbance and particle size.
2. Whole egg powder can be produced using oven, sun, dehydrator and air drying
3. Whole egg powder made from air-drying had optimized properties

Recommendations:

1. Dehydrator and air-drying methods are recommended for adoption
2. Dehydrator dried powder is recommended based on its high functionality

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