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EFFECTS OF CRUDE RED FRUIT (*PANDANUS CONOIDEUS LAMK.*) OIL CONCENTRATIONS ON PHYSICOCHEMICAL, TOTAL CAROTENOIDS, AND ORGANOLEPTIC CHARACTERISTICS OF MAYONNAISE

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ABSTRACT

Red fruit (*Pandanus conoideus* Lamk.) oil (RFO) which provides high antioxidant as well as having unique aromas is potentially used for functional food product developments, e.g., mayonnaise. Mayonnaise processing steps involve thermal process for a short time course which decrease risk of bioactive compound degradation in RFO. The present research aimed to determine the effects of RFO and water concentration on physical and organoleptic properties, and total carotenoids contributed by RFO in mayonnaise formulas. The methods comprised of 4 mayonnaise formulas with RFO:water ratios coded F1 (25:45), F2 (20:50), F3 (15:55), and F4 (10:60); while other ingredients, i.e., egg yolk of 5.5%, starch 5%, CMC 1%, citric acid 1%, acetic acid 4%, sugar 7.5%, and *mustard* 3%. Parameters observed were colour, viscosity, emulsion stability, and organoleptic properties, as well as moisture and carotenoid content. Results indicated that all formulas were in the ranges of dark reddish orange to orange in colour, had a specific RFO aroma and mildly acid, viscosity (200 – 240 dPoise); and the emulsion were stable for between 7-13 days stored at room temperature. Organoleptic scores for all formulas obtained 4.66-5.92 (slightly liked to liked) for colour, 4.33-5.25 (slightly liked to liked) for aroma, 4.14-4.96 (neutral to slightly liked) for taste, 5.51-5.70 (slightly liked to liked) for smoothness; and for overall scores were 4.85-5.51 (slightly liked to liked). The best formula was F2 obtained from composition of RFO:water 20:50, with color pale reddish-orange, viscosity of 205 dPoise, stable for 8 days, having 57.75% (w/w) for moisture, and total carotenoids 2550 ppm (db).

Keywords: mayonnaise; crude red fruit oil; organoleptic properties; emulsion stability; carotenoid

ABSTRAK

Minyak buah merah (*Pandanus conoideus* Lamk.) dengan aktivitas antioksidan yang tinggi dan memiliki aroma minyak buah yang khas dapat menghasilkan pangan fungsional seperti mayones. Pembuatan mayones tidak melalui proses termal yang lama, sehingga tidak merusak komponen aktif dari minyak buah merah,. Penelitian ini bertujuan untuk menentukan pengaruh konsentrasi minyak buah merah dan air terhadap sifat fisiko-kimia, organoleptik dan kadar total karotenoid mayones yang dihasilkan. Penelitian ini menggunakan metode eksperimen dengan 4 perlakuan formula mayones, yaitu perbandingan minyak buah merah dan air, dengan kode F1 (25:45), F2 (20:50), F3 (15:55), F4 (10:60) dengan konsentrasi bahan tambahan lain berupa kuning telur 5,5%, pati 5%, CMC 1%, asam sitrat 1%, cuka 4%, gula 7,5%, dan *mustard* 3%. Parameter mayones yang diamati adalah warna, viskositas, stabilitas emulsi, dan sifat organoleptik; serta kadar air dan karotenoidnya. Hasil penelitian menunjukkan bahwa sifat fisik keempat formula mayones adalah merah jingga tua hingga jingga, beraroma khas buah merah dan sedikit beraroma asam, viskositas (200-240 dPoise), stabil selama 7-13 hari pada penyimpanan suhu ruang. Sifat organoleptik keempat formula yaitu warna dengan skor 4,66 – 5,92 (agak suka sampai suka), aroma 4,33 -5,25 (agak suka hingga suka), rasa 4,14 - 4,96 (netral hingga agak suka), kehalusan 5,51-5,70 (agak suka hingga suka) dan keseluruhan 4,85-5,51(agak suka hingga suka). Formulasi terbaik mayones buah merah dari keempat formula F2 dengan komposisi minyak dan air 20:50, berwarna merah jingga muda, beraroma khas buah merah, dengan viskositas 205 dPoise, stabil selama 8 hari, kadar air 57,75% b/b, dan total kandungan karotenoid 2550 ppm (bk).

Kata kunci: mayones; minyak kasar; buah merah (*Pandanus conoideus*); stabilitas emulsi, karotenoid

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INTRODUCTION

RFO (*Pandanus conoideus* Lamk.) has been well-known as one of natural antioxidant sources due to its bioactive compounds, namely carotenoids (carotene, cryptoxanthin, phytoene, capxanthin and violaxanthin) and tocopherol (α-tocopherol and γ-tokoferol), total phenols, as well as unsaturated fatty acids (oleic, linoleic, and palmitoleic acids) that play role as natural antioxidants (Nishigaki et al., 2011; Sarungallo et al., 2015a; Sarungallo et al., 2015b; Fitria et al., 2020). RFO also is reported *in vivo* confirmations the health benefits for instance inhibiting tumor growth and killing cancer cells (Nishigaki et al., 2011), also as antiinflamation agent and increasing immune cells (Ree et al., 2020), furtherore it has high antioxidant activity (Rohman et al., 2010), therefore RFO has great potentials as functional food ingredient.

Current uses of RFO is limited as a health supplement. One of oil based processing products is emulsion, both a simple and a complex emulsion system. The later emulsion such as mayonnaise, margarine, and butter (Pawlik et al., 2013). There have been many products of emulsion developed where mayonnaise is increasingly available in current stores due to its convenience and practical ready to eat for nowadays technology based society. Mayonnaise is oil in water (o/w) based emulsion in the form of semi solid product while its basic ingredients is plant based oil. Plant based oil include palm oil in mayonnaise making (Hutapea et al., 2016), canola oil (Rahmayanti, 2018) and RFO (Sarungallo et al., 2021).

Crude RFO has disadvantages, for instance its gum content gives bitter taste, so it needs degumming process to improve taste and its stability (Sarungallo et al., 2020). Despite, Sarungallo et al., (2021) reported that mayonnaise made from crude RFO contains carotenoid 3376 ppm (higher 13.5%) compared to degumming RFO (2925 ppm) when they have the same concentration. This is due to carotenoid degradation during degumming process. Therefore, crude RFO based mayonnaise needs improving to make it acceptable according to consumers' preferences.

One of mayonnaise quality parameters is emulsion stability which depends on the oil : water ratios (Depre & Savage, 2001). Hutapea et al., (2016) reported oil : water ratios in mayonnaise making 50% for palm oil of total mayonnaise mixture where oil is 35%. Furthermore, Rahmayanti (2018) used 50 g canola oil and 13 g water; meanwhile Liu et al., (2007) made mayonnaise from palm oil (70%), and 15% water. Based on the available literatures, the present research objective is to determine the effects of crude RFO : water ratio in mayonnaise making on physicochemical and organoleptic properties of mayonnaise.

MATERIALS AND METHODS

Materials

Materials in the mayonnaise formulas were crude RFO (Midey variety which was obtained from Kampung Kwau, Distrik Manokwari Selatan, West Papua), sugar, salt, apple vinegar (HEINZ, Indonesia), carboxymethy celluloce (CMC) and citric acid (Gunacipta Multirasa, Indonesia), mustard kuning (French'Dinamik Multi Sukses, Bekasi), egg yolk, maizena (Egafood, Indonesia), food grade water. Chemicals at proanalysis grade included acetone, Butylated hydroxyl toluene (BHT) and ethanol (Merck, Germany) and aquadest.

Mayonnaise preparation

Mayonnaise making method was according to Sarungallo et al., (2021) with minor modification during homogenization steps. The compositions of all formulas are presented in Table 1. Sugar and stabilizer (maizena and CMC) were mixed suspended into water, heated at 85°C until the mixture became thick, and finally were homogenized using a hand blender (Kris, Ace Hardware, America) for 3 minutes, then added with egg yolk and homogenized. This was followed with the addition of citric acid, apple vinegar, and mustard while the mixture was continuously agitated, then it was homogenized again for 3 minutes. The crude RFO were added in two steps, homogenized, the rest amount of water was added. Once again the rest of crude RFO was added and continuously homogenized until it formed a stable

emulsion. The mayonnaise obtained was put into a sterile glass jar or bottle for analyses.

Table 1. Mayonnaise formulation containing crude RFO in 100 g mixtures.

Bahan	F1 (25%)	F2 (20%)	F3 (15%)	F4 (10%)
Crude RFO	25	20	15	10
Water	45	50	55	60
Egg yolks	5.5	5.5	5.5	5.5
Citric acid	1.0	1.0	1.0	1.0
Maizena	5.0	5.0	5.0	5.0
Apple vinegar	4.0	4.0	4.0	4.0
Sugar powder	7.5	7.5	7.5	7.5
Salt powder	3.0	3.0	3.0	3.0
Carboxymethyl celluloce (CMC)	1.0	1.0	1.0	1.0
Mustard	3.0	3.0	3.0	3.0

Physical property analyses

Physical properties were colour through visual observation, sensory sensing for aroma, and viscosity (viscometer, Rion Viscotester VT-04, Japan) according to methods by Fardiaz et al., (1992), emulsion stability was observed visually through coalescence appearances for 14 days (coalescence is the increased of oil droplet sizes which was released out further off the emulsion system of mayonnaise according to methods by Gheorghe et al., (2008).

Chemical property analyses

Moisture content was determined according to the method by AOAC (2005) using analytical balance (Radwag, PT. Intitek presisi integrasi, Jakarta), desiccator (Cable Reel 250 V, Frankfurt, Germany), oven (Memmert type UNB 400, Germany). Total carotenoid content was determined according to a method by Alfarsi et al., (2005) with minor modification. Around 0.10 mg of samples was dissolved into 25 ml acetone-alcohol (1:1, v/v) containing 0.1% butylated hydroxy toluene (BHT). Absorbance of samples and standard solutions were measured using a spectrophotometer (Shimadzu UV mini-1240, Japan) at wave length of 470 nm. A blank was 0.1% BHT in acetone-alcohol (1:1, v/v). The total carotenoids were calculated using equation 1.

$$\text{Total carotenoids(ppm)} = \frac{\text{AbxVx10}^6}{\text{A}^{1\%}\text{x G}} \quad \ldots\ldots\ldots\ldots (1)$$

Ab : Absorbance at 470 nm
V : Total volume extract
$A^{1\%}$: extinction coefficient for a 1% carotenoid mixture (2500)
G : dry weight of the samples

Organoleptic test

Hedonic test aimed at investigating the preferences of panellists towards the colour, aroma, taste, and texture of crude RFO mayonnaise. The evaluation scales were (1) strongly disliked; (2) disliked; (3) slightly disliked; (4) neutral; (5) slightly liked; (6) liked; and (7) strongly liked. Panellists were 25 untrained panellists.

Data Analysis

Research design was a Completely Randomized Design. Data obtained in the present research were analysed with Analysis of variance at confident level of 95% and when there are significant differences of the treatments the analysis was continued for Duncan Multiple Ranges Test applying in SPSS (Statistical Program for Social Science) software version 16.

RESULTS AND DISCUSSION

Physical properties of crude RFO mayonnaise

The crude RFO used in the present research was obtained from dry extraction method (Sarungallo et al., 2014). The mayonnaise formulas were treated with composition of crude RFO of 25%-10% and water 45%-60% (Tabel 1). Thus, the emulsion system of these mayonnaise formulas is oil in water that requires emulsifier and/or stabilizer, namely egg yolk 5.5% and both starch (maizena) 5% and CMC 1%, respectively to help them with their self-lives (Winarno, 2008).

The previous research, the crude RFO mayonnaise was found stable for 3 days when the crude RFO level was at 35% (Sarungallo et al.,2021). The present research tried to improve crude RFO mayonnaise with better colour and emulsion stability by lowering the crude RFO to 10-25%. The decreased oil level resulted in prevention of the emulsion from oil coalescence because

adhesion among various emulsion components in the formulas increased (Nikzade et al., 2012), on the other hand it increased the emulsion stability. Therefore, the consequences of the decreased crude RFO levels affected its physicochemical properties, consumers' acceptance, and self-life. The mayonnaise obtained from the present research are displayed in Figure 1 and characteristic data observed in Table 2.

Figure 1. The appearances of reduced crude RFO level obtained in all mayonnaise formulas (FA: 25%; FB: 20%, FC: 15%, and FD: 10%)

Colour

Food colour is one of key quality attributes that determine consumer behaviour in food product selection (Winarno, 2008). General speaking, mayonnaise colour strongly depends on oil type used (Depree & Savage, 2001). Natural pigments in crude RFO give colour dark red due to high level of carotenoids, i.e., 6784 ppm (Sarungallo et al., 2020), which strongly affected the mayonnaise colour. The colour obtained in all samples indicated a markedly concentration dependence on crude RFO (Table 2).

Data in Table 2 show that formula F1 (25% crude RFO) and F2 (20%) have dark and mild reddish orange in colour, respectively; whereas F3 (15%) and F4 (5%) have dark orange and orange. These give insights that the less crude RFO levels in mayonnaise formulas are responsible for the milder of the red pigments available in mayonnaise therefore the colour becomes milder. Other authors also explained that ratio of RFO and water 7:3 changed emulsion colour from red (100% RFO) to orange (Murtiningrum et al., 2013). Sarungallo et al., (2021) found 35% of crude RFO in mayonnaise gave reddish orange in colour. In summary, lighter red pigment is obtained from lower crude RFO addition. Furthermore, emulsification process distributes crude RFO red droplets as dispersed phase of the emulsion trapped among the continuous phase of water – hydrophilic ingredients where emulsifier helping it appears homogenous and sable (Shabbir et al., 2015).

Table 2. Physical properties of crude red fruit oil (RFO) mayonnaise

Formulas (crude RFO concentrations)	Physical properties			
	Colour	Aroma	Viscosity**	Self-life (days)*
F1 (25%)	dark reddish-orange	RFO	200±0.0[a]	7
F2 (20%)	mild reddish-orange	RFO	205±10.0[a]	8
F3 (15%)	dark orange	RFO, mild acid	215±30.0[a]	8
F4 (10%)	orange	RFO, mild acid	240±0.0[b]	13

*) indicated by coalescence: oil separation from emulsion system; **) the same letter in one column indicates insignificant differences ($p<0,05$)

Aroma

The sensoric attribute of aroma from oil in food products is notably dominant compared to those of other ingredients in mayonnaise making (Rahmawati et al., 2015). However, the total aroma of all mayonnaise formulas are still blended with other ingredients that have strong taste and aroma such as citric acid, vinegar, and mustard. All crude RFO mayonnaise obtained in the present research generally have a specific RFO aroma, and accordingly this aroma blended with mild acids when the lower concentration of crude RFO was applied in formulation as can be seen in Table 2. At concentrations of crude RFO in the range of 20-25% which solely have specific RFO aromas, i.e., F1 (25% crude RFO) and F2 (20%), a then acidic aromas were gradually detected when the RFO levels become 10-15%, notably marked in F3 (15% crude RFO) and F4 (10%). The acidic aromas are from citric acid and apple vinegar used in the formulas which masked by predominant crude RFO aromas in higher crude RFO concentration. Azizah et al., (2015) stated that sun flower oil, olive oil, corn oil, and ground nut oil did not give a strong acidic aroma in mayonnaise formulations containing 75% of those oils, yet mayonnaise

aroma is supposed to be dominant from vinegar used.

Viscosity

Viscosity describes thickness of food products and strongly related to physical properties of mayonnaise quality and its self-life. The thicker viscosity has the higher viscosity value (Kumalasari et al., 2015). The viscosity of all mayonnaise formulas in the present research are 200-240 dPoise (Table 2). Analysis of variance shows viscosity values of mayonnaise samples significantly differ ($p<0.05$), yet the application of Duncan multiple test at confident levels of 95% further points crude RFO concentration 25-15% are similar whereas those compared to 10% crude RFO are in order of F4 > F3 (15%) ≡ F2 (20%) ≡ F1 (25%) due to higher amount of water added when lower concentration of crude RFO applied. The F4 is more stable than other formulas because the water are used to gelatinized starch from maizena as stabilizer structuring starch gels that help further the RFO droplets trapped firmly even though the mayonnaise already cooling down thus it can be stored longer. Such structure failed in the higher concentration of crude RFO because, in reverse, oil-starch/protein might take place instead of strarch granules swelling during heating process step of mayonnaise making. Kumalasari et al., (2015) reports the more water addition in mayonnaise formulation, the thicker mayonnaise obtained and final texture harder. Moreover, maizena starch has high absorption water capacity makes mayonnaise mixture easier to be homogenized and swollen during heating process (Aini et al., 2016). Obviously, high value of viscosity in sample F4 is affected by maizena starch gelatinization.

Emulsion stability

Emulsion stability involves droplet sizes which is uniform in the good configuration with the whole continuous phase (Suryani et al., 2002). It is a key factor for emulsion based product quality where oil proportion in the emulsion system plays a crucial role (Soekarto, 2013). The crude RFO mayonnaise was determined for its emulsion stability for 15 days at room temperature and coalescence became an indicator of destabilised emulsion and the oil released from the system (Gheorghe et al., 2008). The emulsion stability of all formulas in the present research showed life-time varied from 7 days to 13 days (Table 2), i.e., the coalescence had taken place. Table 2 displays the mayonnaise F1 (25% crude RFO) has life time reaching 7 days meaning that the mayonnaise indicated coalescence occurring after it was left at room temperature for 7 days. F1 has the least life time. On the contrary, F4 (10%) keeps stable until day 13, meaning it has the longest life time and the most stable emulsion. Obviously, the lower crude RFO proportion in the mayonnaise formulas lead to more stable emulsion system. Despite the emulsion system of mayonnaise are supported by their viscosity, F1 with the lower viscosity value compared to F4, the role of starch gelatinization of thickener as well as stabilizer seems acting as a secondary contribution of life-time of the emulsion system. The viscosity value differences of F1 to F4 is 40 points for the same maizena and CMC concentrations which did not overtake their contribution on the emulsion stability by the differences of crude RFO proportion by 15%; by which changed from 7 days to 15 days. Moreover, Shabbir et al., (2015) explained that emulsion system oil in water comprised of oil droplets dispersed in water continuous phase; therefore, the emulsion containing lower oil proportion formed small amount of oil droplets which separated by more continuous phase so that the droplets much more difficult to become coalescence. Finally, its stability reached higher self-life.

Moisture content

Water is important food component that determine its appearance, texture, as well as taste (Winarno, 2008). Moisture contents of all samples were insignificant with the values ranged 56.32% - 61.96% (Figure 2).

Therefore, ratio of crude RFO : water taken 10-25% in the formulas studied apparently did not affect the moisture content of mayonnaise. The use of 5% maizena and 1% CMC as stabilizer and thickener are responsible for bound water molecules in the mayonnaise matrix either for starch granule gelatinization or trapped by CMC

polymer. Both starch and CMC are highly capable of holding water (Alam & Nurhaeni, 2008). As a result, the changes of moisture in the formulas up to 60% of total weights did not affect total amount of water which can be released during thermogravimetry to determine the moisture content.

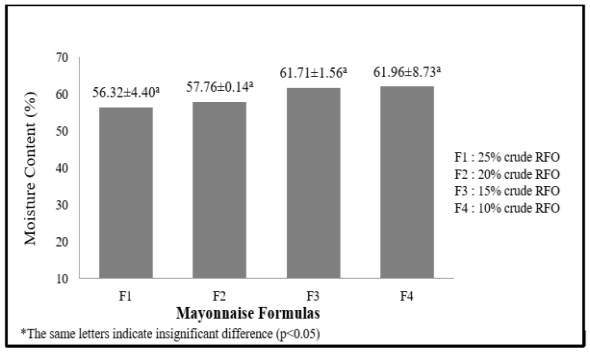

Figure 2. Moisture contents of all crude RFO mayonnaise formulas.

The higher moisture content in mayonnaise formulas are contributed from egg yolk, vinegar, and water (Amertaningtyas et al., 2011). Sarungallo et al., (2021) found that mayonnaise made from crude RFO (35%) and water (40%) produced moisture content of 48.8%. Hutapea et al., (2016) reported that the water content of mayonnaise made from palm oil (35%) with the addition of egg yolks (5-11%) ranged from 55.22-57.92%. Meanwhile, Amertaningtyas & Jaya (2011) reported that soybean oil mayonnaise made from 75% soybean oil and 9% egg yolk has a lower water content, which ranges from 20.7-22.4%. Thus the higher the concentration of oil used the lower the water content of the mayonnaise produced.

Organoleptic properties

Hedonic test in sensory analysis aimed at finding acceptability based on consumer preference toward food product development using a scoring scale method on quality parameters observed (Tarwedah, 2017). Evaluation on organoleptic properties in the present research for colour, aroma, taste, smoothness, and overall evaluation are listed in Table 3.

Colour

Colour is a determinant factor in food product and food stuff quality because it is a primary appearance noticed by consumers at the first sight (Winarno, 2008). Scoring results of sensory evaluation for crude RFO mayonnaise in the present research for colour ranged 4.66–5.92 (neutral to liked), as seen in the Table 3. Analysis of variance on the hedonic test results found that proportions of crude RFO significantly affected the panelist preferences ($p<0.05$) toward colour. Duncan multiple test at confidence levels of 95% shows preferences toward colour of mayonnaise F1 (25% crude RFO) ≡ F2 (20%) ≡ F3 (15%) > F4 (10%). Panelists slightly liked crude RFO mayonnaise with dark reddish–orange colour rather than light orange (Table 2) mayonnaise.

Table 3. Organoleptic properties evaluation based on hedonic test for crude RFO Mayonnaise

Organoleptic Parameters	Formula (crude RFO concentrations)*			
	F1 (25%)	F2 (20%)	F3 (15%)	F4 (10%)
Colour	5.92±0.95^{b}	5.59±1.30^{b}	5.44±1.25^{b}	4.66±1.54^{a}
Aroma	5.25±1.45^{b}	4.66±1.27^{ab}	4.70±1.20^{ab}	4.33±1.59^{a}
Taste	4.66±1.59^{a}	4.96±1.42^{a}	4.85±4.85^{a}	4.18±4.18^{a}
Smoothness	5.51±1.15^{a}	5.70±1.20^{a}	5.70±1.13^{a}	5.62±1.14^{a}
Overall	5.51±1.31^{b}	5.59±0.97^{b}	5.00±0.83^{ab}	4.85±1.40^{a}

The same letters in the same row indicates insignificant differences ($p<0.05$); n= 25 untrained panellists Scoring scale: **1**=strongly disliked **2**=disliked, **3**=slightly disliked, **4**=neutral, **5**=slightly liked, **6**=liked, **7**= strongly liked

The lower crude RFO level at 10% generate lower preferences of the untrained panelists but acceptably better at 15-25% (dark reddish orange to dark orange). This is apparently due to the mayonnaise glossiness and creaminess loss.

Aroma

Aroma requires sensitivity of taste and flavor of the food tested in sensory evaluation test (Setyaningsih et al., 2010). Lioe et al., (2018) stated that taste and aroma are key quality attributes of mayonnaise thus they play important roles as references for sensorial specification in food industry. Hedonic evaluation toward aroma scored at scale of 4.37-5.25 (neutral to slightly liked) can be seen in Table 3. Analysis of variance

on panelist responses toward aroma of all mayonnaise formulas are significantly affected by the concentration of crude RFO ($p<0.05$). Duncan multiple test at confidence level of 95% found that untrained panelist preferences toward aroma of F1 (25% crude RFO) ≡ F2 (20%) ≡ F3 (15%) > F4 (10%) but F4 (10%) ≡ F3 ≡ F2 > F1 indicating that the untrained panelists are capable of sensing a gradual aroma changes in the mayonnaise developed affected by the decreasing crude RFO concentration. Lower concentration of crude RFO lead to specific aroma of RFO disappearing then gradually unmasking the acidic aroma of citric acid and vinegar so that F3 (15%) and F4 (10%) are sensed as slightly acidic (Table 2). The untrained panelists as a local Papuanesse tend to choose mayonnaise with a strong specific aroma generated by crude RFO compared to acidic aroma so F1 (25%) scored the highest 5.25 (slightly liked).

Depree & Savage (2001) reported that oil also acts as an aroma carrier where aromatic compound are mostly essential oil. Therefore, the lower portion of crude oil in the mayonnaise formulas, the more essential oil of crude RFO goes off. Wardani (2012) reported that organoleptic responses of the panelists are neutral toward mayonnaise containing rosella extract (antioxidant flavonoids, red in colour) in the existence of palm oil, coconut oil and soya oil which is less aromatic compared to commercial product. Hence, crude RFO mayonnaise is more likely aromatic than rosella extract which is nonfat matrix. RFO has both red pigment, antioxidant and aromatic oil in it as its excellence.

Taste

Taste is a biological perception, for instance senses, generated by substances inside the oral cavity (Tarwedah, 2017). Table 3 displays scores of untrained panelist toward taste of mayonnaise containing crude RFO that fall into an interval of 4.66-4.96 (neutral to slightly liked). Analysis of variance results in insignificant effects of crude RFO concentration on the taste preferences by untrained panelist ($p>0.05$). Winarno (2008) stated that intensity of taste sensed by panelists is lowered by food matrix viscosity: the more viscous the food matrix, the lesser taste can be detected by panelists. In this present research, it is not the case because panelists scored them relatively equal (insignificantly differed) while viscosity values of all crude RFO mayonnaise ranged 200-240 dPoise. Moreover, Azizah et al., (2015) reported that the taste of mayonnaise developed using sunflower seed oil, olive oil, groundnut oil, and corn oil affected by vinegar. Hence, taste contributed by other ingredients vary depend on the amount and types of food ingredients used. Finally, Lioe et al., (2018) shared the finding that the uses of plant based oil in mayonnaise making are significantly affected by the taste of specific oil sources, acidic taste form acid sources, eggy taste from egg yolk, and mustard taste.

Smoothness

Smoothness of emulsion products play an important role in acceptance of their quality, as well as sensorial attributes triggered in the oral cavity (Heenen et al., 2003). Scores for smoothness in Table 3 show that the untrained panelists liked all mayonnaise formulas at scale of 5.51–5.70 (slightly liked to liked). Analysis of variance found that the different levels of crude RFO in the mayonnaise formulas affected insignificantly on smoothness attribute ($p>0.05$). Further Duncan multiple test at confidence level of 95% did not show significant differences for all formulas (Tabel 3). Kumalasari et al., (2015) stated that mayonnaise texture is affected by viscosity: the more viscous the mixtures, the lower panelists' acceptance due to its coarse texture. Viscosity values of all mayonnaise studied ranged 200-240 dPoise did not lead to significant effects on smoothness of crude RFO mayonnaise.

Overall evaluation

The overall evaluation of the crude RFO mayonnaise quality are considering all aspects of preferences from panelists, which observed at scale of 4.85 -5.59 (neutral to liked) as listed in Table 3. Analysis of variance indicates significant effects of amount of crude RFO on the overall quality of mayonnaise formulas ($p<0.05$). The results of Duncan multiple test at confidence level of 95% revealed that untrained panelists' preferences for F1 (25% crude RFO) ≡ F2 (20%) ≡ F3 (15%), but

F3 (15%) and F4 (10%) significantly differed from F1 and F2 (Table 3). Hence, mayonnaise formula used 20% crude RFO (F2) was selected as the potential better acceptability when it is commercialized and go to market based on its taste, with the highest score amongst others.

Total carotenoids

RFO is well-known as a great source of carotenoids (Nishigaki et al., 2011; Sarungallo et al., 2015a). Incorporation of crude RFO into mayonnaise formulas in the present research are shown in Figure 3. The total carotenoids in all mayonnaise formulas fell into the interval of 1810-3230 ppm (db).

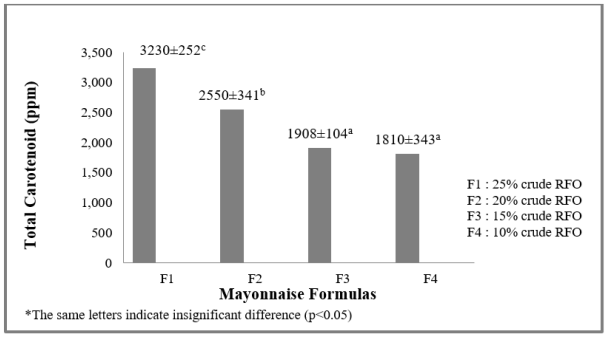

Figure 3. Total carotenoid contents in all crude RFO mayonnaise formulas

Analysis of variance showed that reduction in crude RFO concentration in mayonnaise formulas significantly affected total carotenoid contents of final mayonnaise produced ($p<0.05$). Duncan multiple test at confidence level of 95% total carotenoid content of F1 (25%crude RFO) significantly differed from those in F2 (20%) whereas F3 (15%) and F4 (10%) insignificantly differed, nevertheless both showed significant differences from those in F1 and F2. Total carotenoid content in the present research were lower than those in research results by Sarungallo et al., (2021) i.e., 3376 ppm (db) from formulas with 35% of crude RFO. It is acceptable that the increase of crude RFO in the formulas proportionally increase total amount of carotenoids.

CONCLUSION

Effects of crude RFO - water ratios on physicochemical and organoleptic properties of crude RFO mayonnaise in the present research showed significant changes on several parameters. The uses of decreasing crude RFO from 25% to 10% in mayonnaise formulation resulted in mayonnaise with: (a) dark reddish orange to orange in colour, (b) specific RFO aroma and gradually replaced by acidic aroma from apple vinegar and citric acid, (c) viscosity value fell into interval of 200-240 dPoise, and their emulsion stability reached self-life of 7-13 days during the storage at room temperature, (c) moisture content of 56.32% - 61.96%, and total carotenoids around 1810-3230 ppm (db). The untrained panelists responded to sensory test on hedonic test gave color scale of 4.66 – 5.92 (slightly liked to liked), aroma 4.33 – 5.25 (slightly liked to liked), taste 4.14 – 4.96 (neutral to slightly liked), smoothness 5.51 – 5.70 (slightly liked to liked), and overall 4.85 – 5.51 (slightly liked to liked). In conclusion, the best crude RFO mayonnaise is obtained from formula with 20:50 crude RFO-water ratio (F2) characterized by mild reddish orange in color, RFO specific aroma, viscosity value of 205 dPoise, stable for 8 days without coalescence, containing 57.75% wb water, and total carotenoids of 2550 ppm (db).

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