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# Implications of Covid-19 Pandemic on MSMEs to Economy, Society: Case in the Country of Indonesia

Wastam Wahyu Hidayat\*, Soehardi, Ery Teguh Prasetyo, Cahyadi Husadha

<sup>1</sup>Department of Management Universitas Bhayangkara Jaya Jakarta, Indonesia

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## ABSTRACT

Based on research in the MSME sector in Indonesia experienced the impact of the COVID-19 Pandemic. The successive impacts are declining sales, capital difficulties, product distribution barriers, and raw material difficulties. The government has issued: (a) social assistance to poor and vulnerable MSMEs, (b) tax incentives for MSMEs; relaxation and restructuring of credit for MSMEs; expansion of working capital financing of MSMEs; placing ministries, state-owned enterprises and local governments as buffers for MSME products;

and e-learning Training. To support government policy, several short-term strategies and long-term strategies need to be considered by the government and encourage government collaboration with corporations in empowering MSMEs.

**Keywords:** MSMEs; COVID-19; Economy

## Correspondence:

Wastam Wahyu Hidayat, Faculty Economic and Business, Universitas Bhayangkara Jakarta Raya, Indonesia E-mail: [wastam.wahyu@dsn.uhharajaya.ac.id](mailto:wastam.wahyu@dsn.uhharajaya.ac.id)

## INTRODUCTION

COVID-19 has become a global problem worldwide including in Indonesia. As of May 30, 2020, Covid-19 infected patients nationwide reached over 6 million with a mortality rate per 1 million people of 47 people (Wordometer, 2020). (Table 1) presents the largest data of COVID-19 infected patients in the world and Indonesia. When viewed based on the data, Indonesia ranks 32nd in the world for total cases of patients infected with COVID-19.

The COVID-19 pandemic has economic, social, and political implications in almost all countries, including Indonesia (Susilawati S, *et al.*, 2020) and (Pakpahan Ak, 2020). The World Trade Organisation (WTO) estimates that world trade volume globally is likely to decline by about 32% by 2020 during the COVID-19 period (Islam A, 2020). Restrictions on community activities as an effort to address the COVID-19 pandemic have caused significant economic losses nationally (Hadiwardoyo W, 2020). The sectors affected during the COVID-19

Table 1: World's largest Covid-19 infected patient data

No	Country	Total cases	Died	Population	Death /1 Millian Population
0	Dunia	6.023.032	366.372	7.794.798.739	47
1	Amerika Serikat	1.792.822	104.523	330.827.597	316
2	Brasil	466.2	27.923	212.422.152	131
3	Rusia	387.623	4.374	145.928.996	30
4	Spanyol	285.644	27.121	46.753.197	580
5	Inggris	271.222	38.161	67.853.964	562
6	Italia	232.248	33.229	60.469.504	550
7	Perancis	186.835	28.714	65.260.761	440
8	Jerman	183.019	8.594	83.760.156	103
9	India	173.491	4.98	1.378.752.175	4
10	Turki	162.12	4.489	84.254.857	53
11	Indonesia	25.216	1.52	273.255.522	9

17 pandemic are transportation, tourism, trade, health, and other sectors, but the sectors of the economy most affected by COVID-19 are the household sector (Susilawati S, et al., 2020). Meanwhile, according to the (OECD, 2020) and (Febrantara D, 2020), the business sectors that have a significant impact are tourism and transportation.

The economic impact of the COVID-19 pandemic (BNPB, 2020) is also felt in the Micro, Small, and Medium Enterprises (MSMEs) sector. This is because MSMEs occupy a strategic position in the economy in general. In ASEAN, MSMEs generate jobs between 50% to 95% and contribute between 30% to 50% of GDP (Islam A, 2020). In Indonesia itself, MSMEs are one of the strategic sectors in the national economy that can be seen from the absorption of labour (Abidin M, 2015). Small businesses are among the hardest hit by the COVID-19 crisis, many are temporarily closing businesses, and further facing cash flow constraints (Baker T and Judge K, 2020).

The OECD (2020) itself mentions that MSMEs are currently at the center of the economic crisis due to the COVID-19 pandemic, even with conditions worse than the 2008 financial crisis. Crisis due to pandemic will affect MSMEs with serious risks where more than 50% of MSMEs will not survive the next few months. The collapse of MSMEs can broadly have a strong impact on the national economy and global growth prospects, on perceptions and expectations, and even on the financial sector.

Considering that 60%-70% of jobs in OECD countries are played by MSMEs and moreover, there is pressure by portfolios that do not have performance. The deterioration of the financial situation of MSMEs can have a systemic effect on the banking sector as a whole (OECD, 2020).

According to Febrantara, 2020 and OECD, 2020, the impact of the COVID-19 pandemic on MSMEs can be seen in terms of supply and demand. From the offer, with the Covid-19 pandemic, many MSMEs are experiencing labour shortages. This happens for reasons of maintaining the health of workers and the enforcement of social distancing restrictions. Both causes led to people's reluctance to work while there was still a COVID-19 pandemic. On the demand side, the reduced demand for goods and services has an impact on SMEs not being able to function optimally which leads to reduced liquidity of the company. This causes people to lose income because SMEs are not able to pay workers wage rights. In the worst case, termination of employment occurs unilaterally.

More than 106 countries have introduced or adopted social protection programs as well as labour market interventions in response to COVID-19 (Gentilini U, et al., 2020). Generally, every country has a policy mix to keep the MSME sector afloat during the pandemic and after the COVID-19 pandemic. This study aims to describe the government's policy in saving MSMEs from the impact of the COVID-19 pandemic in Indonesia. In addition, the research is intended to provide an overview of what strategies can be taken as a complement to the policy.

After conducting literature studies and observations on various government policies to save the MSME sector, it can be said that the research conducted by the author is research that has elements of novelty

and originality. This research is also still relatively rare, because photographing current policies, so it can be submitted as a frame of reference and or lighter for future research.

## LITERATURE REVIEW

### Micro and Medium Enterprises (MSMEs)

According to Law No. 20 of 2008, Small and Medium Enterprises (SMEs) are types of small businesses that have a net worth of at most IDR 200,000,000 excluding land and buildings of businesses and a stand-alone effort. Furthermore, in this paper, SMEs will be likened to MSMEs.

Indonesia, which is dominated by Micro, Small, and Medium Enterprises (MSMEs) needs to pay special attention to this sector because of the contribution of MSMEs to the national economy (Pakpahan AK, 2020). There are at least three very important roles of SMEs in the lives of small communities, namely the means of eradicating people from the abyss of poverty, the means to level the economy of small people, provide foreign exchange for the country (Prasetyo A and Huda M, 2019).

In 2018 there were 64,194,057 MSMEs in Indonesia (or about 99 percent of the total business units) and the MSMEs sector has employed 116,978,631 workers or about 97 percent of the total workforce in the economic sector (Kemenkop-UKM, 2018). In 2018, MSMEs contributed GDP on the basis of prevailing prices of 61.07% nationally (Kemenkop-UKM, 2018). MSMEs in Indonesia have increased from year to year (Databoks, 2020).

### Impact of pandemic on MSMEs in Indonesia

Indonesia is one of the countries affected mainly on the economic side (Pakpahan AK, 2020). The Covid-2019 pandemic has a variety of impacts on the economy such as difficulties in finding jobs, difficulty to meet the needs of daily life, having no income in meeting the needs for daily and also many difficulties received from all sectors of the economy in all fields also feel the impact of Covid-19 (Hanoatubun S, 2020).

As of April 17, 2020, a total of 37,000 MSMEs have reported themselves to the Ministry of Cooperatives and SMEs affected by the COVID-19 pandemic (Setiawan D, 2020). According to the data release, the difficulties experienced by MSMEs during the pandemic were divided into four problems. First, there is a decrease in sales due to reduced activities of people outside as consumers. Second, capital difficulties due to difficult capital turnover due to declining sales levels. Third, there are barriers to product distribution due to restrictions on the movement of product distribution in certain regions. Fourth, the difficulty of raw materials because MSMEs depend on the availability of raw materials from other industrial sectors. (Table 2) shows that of the four issues, the impact of declining sales becomes the biggest problem felt by MSMEs. The impact of the pandemic on SMEs is believed to be greater, due to the high level of vulnerability and lack of resilience due to limited human resources, suppliers, and options in overhauling the business model (Febrantara D, 2020).

Table 2: Impact of COVID-19 on MSMEs

Impact	Percentage (%)
Sales Decline	56,0
Capital Difficulties	22,0
Product distribution barriers	15,0
Raw material difficulties	4,0

**Government efforts to save MSMEs in Indonesia**

30 The of the literature is used to trace various directions and policies carried out by the Indonesian government in protecting MSMEs from the impact of the COVID-19 pandemic. The Government of Indonesia needs to make various efforts to help the community economy through various policies (Susilawati S, *et al.*, 2020). The success of the government's policy depends heavily on the support of the business component in the community. The community and the government must jointly protect the economy from the impact of Covid-19 (Hanoatubun S, 2020).

The rise of MSMEs after COVID-19 is in desperate need 24 of support and all stakeholders. For example, for the tourism sector business travel partners, travel agencies, hospitality, educational institutions, financial institutions, local communities, insurance, and from cooperation with similar industries (Hadi S, 2020). Hadi recommended that the policy of revitalization of MSMEs be carried out by increasing synergy between programs and between government agencies, increasing the variety of modern promotion efforts of MSMEs products to the domestic and export markets, the implementation of credit policies with low-interest rates and simple processes, and encouraging the improvement of MSME support facilities and the creativity of MSMEs to be highly competitive.

**METHODS**

This study uses descriptive qualitative methods by utilizing secondary data derived from various literatures such as books, articles, and homepages to access the latest 44 and information related to the policy of saving MSMEs from the impact of the COVID-19 pandemic. The use of descriptive qualitative methods aims to provide a description and get a clear picture that is useful to answer the problem formulation,

11 namely on how government policy in saving MSMEs from the impact of the COVID-19 pandemic and what strategies can be taken as a complement to the policy.

**RESULTS AND DISCUSSION**

**Policies of other countries**

Many countries have introduced or adopted mixed programs to save the small and medium-sized business sector or MSMEs (OECD, 2020). First, provide salary subsidies to MSMEs who cannot afford the salaries of their employees. Second, encourage the development of self-employed innovation in order to absorb the unemployed workforce. Third, provide suspension of settlement of MSME obligations or debts for both tax obligations and business loan obligations. Fourth, provide loans directly to MSMEs in order to have enough capital to maintain the business. Fifth, encourage the digitization of MSME businesses in order to continue to operate in conditions where there are restrictions on the movement of people. (Table 3) presents a summary of how COVID-19 is handled in several countries. Fiscal instruments such as income tax deferral (PPh) are still a common choice used by many countries in overcoming the Covid-19 pandemic (Febrantara D, 2020). Efforts to encourage the self-employed are also carried out with the implementation of labour training in order to have enough work skills. In addition to salary subsidies and labour training, several countries also intervened in the field of the labour market in the MSME sector, among others, with changes in labour market regulation/governance and reduction of workers' working hours (Gentilini U, *et al.*, 2020). Intervention through wage subsidy for the MSME sector is carried out by several countries such as China, France, Japan, Serbia, Thailand, and Venezuela (Gentilini U, *et al.*, 2020). (Table 4) presents efforts to save MSMEs in several countries through labour market intervention efforts.

**Table 3: Rescue efforts for MSMEs by several countries**

No	Negara	Wage Subsidies	Growth Self Employed	Suspension PPh	VAT	Relaxation Loan	Loan Direct MSMEs	Digitization
1	Malaysia	-	-	-	-	√	√	√
2	Singapura	√	-	√	-	-	√	-
3	Vietnam	3	-	√	-	-	-	-
4	Amerika Serikat	√	√	√	√	√	√	-
5	Belanda	√	√	√	√	√	-	-
6	Cina	√	-	√	√	√	√	√
7	Inggris	√	√	√	√	√	√	-
8	Arab Saudi	-	-	-	-	√	√	-
9	Turki	√	-	√	√	√	√	√
10	Jepang	√	-	√	√	-	√	√
11	Korea Selatan	√	√	-	-	√	-	√
12	Australia	√	√	√	√	√	√	-
13	Italia	√	√	√	√	√	√	√

**Table 4: Labor market intervention in several countries**

Intervention form	Percentage (%)
Salary subsidies	36
Labor reactivity throughout training	11
Adjustment of labor market regulation/governance	11
Reduced working hours	3
Total Programs	61

Policy-making authorities in China intervene in the form of economic stimulus to stabilize or sustain economic growth (Fernandes N, 2020). After the COVID-19 pandemic, even three months after the outbreak, the Chinese economy will not operate normally. MSMEs are key because, in almost all countries, MSMEs employ a lot of productive personnel. Proper policy-making to restore the economy is decisive, especially with regard to maintaining the liquidity of MSMEs, supporting affected families, the reaction and readiness of the business world to start its economic activities (Fernandes N, 2020). Policymaking is also highly dependent on the length of the reduction of social activities or lockdown.

Good policy measures are also exemplified by Saudi Arabia which puts forward a series of coordinated policies with the main goal of protecting people and maintaining economic stability (Sikki KL, 2020). The Government of Saudi Arabia provides a waiver for business owners within a period of 3 months to delay the payment of VAT, Excise Tax, Income Tax, and the submission of zakat statements and other payment of obligations (Sikki KL, 2020). The Ministry of Finance of Saudi Arabia also provides financing assistance in the form of loans as well as exemption from loan repayments and costs until the end of 2020 in the company's sustainability program initiative (Sikki KL, 2020).

Denmark compensates 75% of MSMEs, who have fewer than 10 employees and suffer losses of about 30% or more (Febrantara D, 2020). Italy built a digital portal that is provided at no cost to MSMEs in order to keep the wheels of business in the pandemic (Febrantara D, 2020).

The U.S. government responds with a soft loan program for several business sectors, providing cash for those in need to retain workers, pay rent, and help their businesses come back to life (Baker T and Judge K, 2020). The U.S. government needs to find new and creative ways to work with existing intermediaries, including banks and online lenders, that have the infrastructure and tools needed to help small businesses get the additional loans they need to survive and thrive (Baker T and Judge K, 2020). Utilizing existing agencies can increase the speed, scale, and scope of government responses, all-important policies are made in an effort to support small businesses in the USA (Baker T and Judge K, 2020).

#### **MSME rescue policy by Indonesia**

On February 25, 2020, the Indonesian government issued a USD725 million policy package for financial incentives for various tourism, aviation, and property sectors, as well as the addition of subsidies and tax cuts (OECD, 2020). There are five schemes for the protection and recovery of cooperatives and MSMEs in the midst of the Covid-19 pandemic (Kemenkop-UKM, 2020), namely: (a) providing social assistance to poor and vulnerable MSMEs sector businesses, (b) tax incentives for MSMEs; (c) credit relaxation and restructuring for MSMEs; (d) expansion of WORKING CAPITAL financing of MSMEs; (d) place ministries, SOEs and Local Governments as buffers for MSMEs products; and (e) e-learning training.

#### **Social assistance**

Social assistance is provided to MSMEs who fall into the category of poor and vulnerable (Kemenkop-UKM, 2020). Included in this social assistance scheme is a 50 percent reduction in electricity tariffs for electricity customers with a capacity of 450 watts over three months (Arifin D, 2020), which can generally be workers or MSMEs. The constraint of giving the social assistance is that there are still many recipients who have not been recorded in detail.

#### **Tax incentives**

The provision of tax incentives for MSMEs is given to MSMEs with a turnover of less than IDR. 4.8 billion Per year (Kemenkop-UKM, 2020). The form of stimulus for PPh is the imposition of a zero percent PPh tariff given for six months, namely the period of April to September 2020. But according to Setiawan D, 2020), this facility is still widely untapped by MSMEs. As of May 29, 2020, the number of tax incentive applications reached 375,913 applicants. Of these applicants, 345,640 or about 91.9% of applications were granted.

#### **Credit relaxation and restructuring for MSMEs**

This policy is a policy issued on March 13, 2020, in response to non-fiscal easing or restructuring of bank loans to MSMEs in conjunction with simplification of the certification process for exporters and ease of import of raw materials (OECD, 2020). The government will provide credit relief below IDR.10 billion, especially for informal workers (online motorcycle taxis, taxi drivers, MSMEs, fishermen, residents with daily income) effective in April 2020 (Maftuchan A, 2020). The SME credit restructuring stimulus package in several provincial governments, especially Central Java, is complemented by the additional intervention (OECD, 2020). In line with the policy, on March 19, 2020, Bank Indonesia announced a 50 basis point (bps) reduction in reserve requirement ratio for banks involved in MSME financing, after cutting 50 basis points (bps) in the previous month to support trade activities (OECD, 2020). Financial assistance to MSMEs is also done by encouraging the banking sector to provide soft loans to MSMEs with strict mechanisms (Pakpahan AK, 2020).

#### **Expansion of MSME working capital financing**

The expansion of WORKING CAPITAL financing of MSMEs is done by encouraging banks to be able to provide soft credit to MSMEs. Thus MSMEs have enough working capital to be able to run their business. This policy is necessary to maintain the liquidity of MSMEs (Pakpahan, 2020). This program is targeted at 23 million MSMEs who have never received financing from banks and financial institutions. Setiawan D, 2020, mentioned that this financing expansion program is given both to MSMEs that are "bankable" and not "bankable".

#### **Product buffer provision**

Cooperative products and MSMEs in agriculture, fisheries, culinary, and household industry need to get buffer support. Thus, there is the certainty that MSME products will be absorbed, so that cooperatives and MSMEs will be able to have a better inventory turnover.

This policy will be more beneficial if followed by efforts to increase the flow of safe distribution, for example by providing reliable e-commerce facilities or services in buffer areas.

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### **MSME labor market intervention through training with e-learning methods**

Indonesia intervenes in the labour market by conducting pieces of training intended to reactivate the labour market through the Prakerja Card launched in April 2020. This program provides subsidized skilling and re-skilling training for 5.6 million affected workers, especially in the small and micro-business sectors (Gentilini U, *et al.*, 2020). Participants of the pre-employment card program can be workers of the MSME sector who have been affected by the termination of employment or new workers who have not yet obtained a job. This policy is in <sup>21</sup> with the self-employed growth policy carried out by several OECD countries such as the United States, The Netherlands, United Kingdom, South Korea, Australia, and Italy (OECD, 2020).

### **Implementation of health protocols in the business world**

May 20, 2020, issued provisions on COVID-19 prevention protocols in public areas, especially for service and trade (Ministry of Health, 2020). The provision applies to administrators or managers of workplaces/businesses, workers, and consumers/customers. According to MediaIndonesia.Com, 2020 the movie is recommended by the Ministry of Cooperatives and MSMEs, among others, in the form of the use of masks by both MSME sector actors and the public as users of MSMEs products or services.

### **Other strategies to take as a policy complement**

In accordance with the development of government policy implementation to empower MSMEs affected by the COVID-19 pandemic, there are several additional steps that can be taken as a complement <sup>21</sup> existing policies. These complementary strategies can be either **short-term** or **long-term strategies**.

#### **Short term strategy**

1. A short-term strategy is needed so that government policies to save MSMEs today can run effectively during and after the COVID-19 pandemic. Some short-term measures or strategies need to be encouraged to support MSME rescue measures by the government. The move relates to the implementation of strict health protocols, the provision of opportunities and encouragement of digital services as supporters of MSMEs, socialization to associations and businesses, simplification of administrative processes, and efforts to encourage changes in business strategy. Each of these short-term strategies is described as follows.

1. MSMEs need to carry out strict health protocols in carrying out their economic activities. Even Pakpahan AK, 2020 suggests that strict health protocol can also be applied when the government grants permission for MSMEs to carry out their activities, meaning that only MSMEs that meet the health protocol requirements are allowed to operate.

2. The Government can provide space and support for the development of digital services because it can reduce physical interaction but the transaction process can still occur. The government can cooperate with BUMN, BUMD, or expedition companies to deliver MSME products. Incentives for these companies can be considered so that shipping costs do not become additional costs that burden sellers and buyers. According to Burhan FA, 2020, during this pandemic food delivery service users increased by 30%. Digital marketing needs to be introduced to MSMEs to become one of the efficient promotional and marketing strategies.

3. Business associations such as Apindo, Kadin, and IPMI need to actively socialize government policies, and encourage all stakeholders in MSMEs to take the bestrole.

4. No less important than the success of government policy is efforts to simplify the administrative process related to the policy of easing or delaying credit payments for MSMEs.

5. Strengthening the monitoring and evaluation process of the covid-19 empowerment work program.

6. The Government conducts coaching to MSMEs by encouraging innovation and changing business strategies to adjust the situation.

For example, MSMEs that initially did culinary business can change the business to food raw materials, considering that nowadays people prefer to cook their own food at home. According to Burhan FA, 2020, after the pandemic, direct orders at restaurants dropped from 80% of total transactions to 60% of total transactions.

### **Long term strategy**

The long-term strategy is aimed at ensuring that in the future MSMEs can remain a major player in the economy after the COVID-19 pandemic. The long-term strategy is related to preparing a roadmap for MSME development, building digital technology as a platform in the business process of MSMEs, developing a modern MSMEs business model, and encouraging government collaboration with corporations in empowering MSMEs. Each of these long-term strategies is described as follows. First, the Government needs to create a road map of MSME development in the face of the business world after COVID-19 in particular and the business world in general. MSME businesses need to be provided with information about understanding business forms in the industrial era 4.0. Prakerja program can be used as a lighter to hone the skills of MSMEs in facing the digitalization era in the future. Second, strengthening the use of digital technology to support the economic activities of MSMEs. This effort is a continuation of the short-term strategy, but in the long-term strategy, digital technology should be the main platform in the business process of MSMEs. This is in line with (Pakpahan's AK, 2020) opinion which states that in the future MSMEs can use digital technology for the production process, product promotion, or determine the potential market for their products. Third, the government can provide a model of fostering MSMEs by cooperating with institutions or academic institutions in the field of entrepreneurship and business management so that MSMEs can become a real manifestation of business practices in accordance with the development of the business world. Hadi's S, 2020 research in Yogyakarta shows that the practice of using analysis models such as Business Model Canvas (BMC) can be chosen to formulate the best strategy in developing MSMEs post-COVID-19. Fourth, the Government needs to cooperate with large businesses and corporations both privately owned and government (SOEs) to be able to channel funds or organize Corporate Social Responsibility (CSR) programs. These companies can foster MSMEs as partners in their line of business, thus indirectly having a positive impact on the sustainability of the company itself as a CSR provider.

### **CONCLUSION**

Based on the research above, we can conclude that <sup>2</sup> just like in almost all countries, the MSME sector in Indonesia is experiencing the impact of the COVID-19 Pandemic. The successive impacts are declining sales, capital difficulties, product distribution barriers, and raw material difficulties. The government has issued a policy in order to deceive MSMEs in the situation of the COVID pandemic-There are several MSME protection schemes conducted by the government, namely

- (a) <sup>10</sup> Providing social assistance to poor and vulnerable MSMEs
- (b) Tax incentives for MSMEs

- (c) Credit relaxation and restructuring for MSMEs
- (d) Expansion of working capital financing of MSMEs
- (e) Place ministries, state-owned enterprises, and local governments as buffers for MSMEs products; and
- (f) e-learning training.

To support government policy, several short-term strategies and long-term strategies need to be considered by the government. The short-term strategy relates to the implementation of strict health protocols, providing opportunities and encouragement of digital services as a supporter of MSMEs, socialization of business associations, simplification of administrative processes, and efforts to encourage changes in business strategies. The long-term strategy relates to preparing a road-map for MSME development, building digital technology as a platform in MSME business processes, developing modern MSMEs business models, and encouraging government collaboration with corporations in empowering MSMEs.

#### ***TC and its processed products reduced the SS immune response in the small intestine***

Figure 2 shows that TC and its processed products had a decreasing effect on the IOD of SS immunoreactivity in endocrine cells in the small intestine, and the decreasing effect gradually increased with prolongation of drug administration. After 7 days of administration, the IOD of SS immunoreactivity in the small intestine in the low and high RTC groups was significantly decreased ( $P<0.01$ ). After 7 and 14 days of administration, the IOD of SS immunoreactivity in the small intestine in the high and low ETC groups was significantly decreased ( $P<0.01$ ). The IOD of SS immunoreactivity in the small intestine in the high and low TC groups was also significantly decreased ( $P<0.01$ ). After 14 days of administration, the IOD of SS immunoreactivity in the small intestine in the high RTC group was significantly lower than that in the low TC group ( $P<0.01$ ). After 21 days of administration, the IOD of SS immunoreactivity was significantly lower in the high RTC group than in the high TC group ( $P<0.01$ ). Moreover, the IOD of SS immunoreactivity in the low RTC group was significantly lower than that in the low TC group ( $P<0.01$ ). The IOD of SS immunoreactivity in the small intestine in the high ETC group was significantly lower than that in the low TC group ( $P<0.01$ ). After 28 days of administration, the IOD of SS immunoreactivity in the small intestine in the high RTC group was significantly lower than that in both the high and low ETC groups ( $P<0.01$ ) and significantly lower than that in the high TC group ( $P<0.01$  or  $0.01<P<0.05$ ). Furthermore, compared with that in the low TC group, the IOD of SS immunoreactivity in the small intestine in the low ETC group was significantly decreased ( $P<0.01$ ).

The IOD of SS immunoreactivity in the small intestine in the high TC group was significantly lower than that in the low TC group ( $P<0.01$  or  $0.01<P<0.05$ ). After 14, 21 and 28 days of administration, the effects of high doses of *Terminalia chebula* and its processed products on the IOD of SS immunoreactivity in the small intestine were significantly stronger than those of low doses of these drugs.

The results of grayscale analysis (Figure 3) showed that TC and its processed products had an increasing effect on the average grayscale value of SS immunoreactivity in endocrine cells in each segment of the small intestine and that the increasing effect was gradually enhanced with prolongation of drug administration. After 7 days of administration, the gray value of SS immunoreactivity in the small intestine in the high and low RTC groups was significantly increased ( $P<0.01$ ). The gray val-

ues of SS immunoreactivity in the small intestine in the high and low ETC groups were significantly increased after 21 and 28 days of administration ( $P<0.01$ ). The gray value of SS immunoreactivity in each segment of the small intestine in the high TC group was significantly increased after 28 days of administration ( $P<0.05$ ). The gray value in the SS immunoreactivity in the small intestine in the high RTC group was significantly higher than that in the low TC group after 7 days of administration ( $P<0.01$ ). After 14 days of administration, the gray value of SS immunoreactivity was significantly higher in the high RTC group than in the high TC group ( $P<0.01$ ). After 21 days of administration, the gray value of SS immunoreactivity was significantly higher in the high RTC group than the low ETC group ( $P<0.01$ ). After 28 days of administration, the gray value of SS immunoreactivity was significantly higher in the high RTC group than in the high ETC group ( $P<0.01$  or  $0.01<P<0.05$ ). The gray value of SS immunoreactivity in the small intestine in the low RTC group was significantly higher than that in the low TC group after 7 days of administration ( $P<0.01$ ). After 28 days of administration, the gray value of SS immunoreactivity was significantly higher in the low RTC group than in the high TC group ( $P<0.01$ ). After 28 days of administration, compared with those in the low TC group, the gray values of SS immunoreactivity in each segment of the small intestine in the high and low ETC groups were significantly increased ( $P<0.01$ ). Compared with that in the low TC group, the gray value of SS immunoreactivity in the small intestine in the high TC group was significantly increased after 28 days of administration ( $P<0.01$  or  $0.01<P<0.05$ ). Overall, after 7, 14, 21 and 28 days of administration, the effects of high doses of TC and its processed products on the gray value of SS immunoreactivity in the small intestine were significantly stronger than those of the low doses of these drugs.

## **DISCUSSION**

### ***Effects of TC and its processed products on SS immunoreactivity in the small intestine***

Somatostatin is a neuropeptide and a key regulator of the growth axis (Jing M *et al.*, 2020). It is widely distributed in many tissues and organs of many animals, especially in the gastrointestinal tract and pancreas (Patel Y *et al.*, 1981). The effect of somatostatin on the gastrointestinal tract is complex; it inhibits the exocrine function of the stomach, pancreas and bile, decreases motility and influences absorption. Furthermore, SS inhibits the release of gastrointestinal hormones, resulting in alterations in the secretion of gastrointestinal hormones related to the digestive and absorption functions of the gastrointestinal tract (László *et al.*, 2020). In mice, Somatostatin Receptor Subtype 1 (SSTR1) modulates the inhibition of growth hormone release (Kreienkamp H *et al.*, 1999). SSTR2 plays an important role in the physiological function of the gastrointestinal tract (Rong W *et al.*, 2007). In the present experiment, we found that the number of SS cells in the small intestines of mice increased with the prolongation of drug administration. This is consistent with the results of Zhang Sujuan (Zhang S *et al.*, 2009), who showed that the number of somatostatin-immunoreactive cells in the gastrointestinal tracts of mice during early postnatal development increased significantly with age. SS can inhibit many kinds of gastrointestinal hormones and enzymes and gastrointestinal motility. It is widely distributed in the small intestines of mice, but its density is low, which is beneficial for the release of other gastrointestinal hormones in the small intestine, especially 5-HT. In addition, it can balance the content of 5-HT.

After 7 days of administration, there was no significant difference in SS immunoreactivity. After 14 days of administration, with the prolongation of drug administration, the difference in SS immunoreactivity be-

tween each group and the control group was increased, which may have been related to changes in the drug concentration of TC and its processed products in the blood. Immunoreactivity in the high dose-treated group was significantly higher than that in the low dose-treated group after the same duration of administration, indicating that the effects of TC and its processed products on SS show a certain dose-effect relationship. If the dose is too small and the administration time is short, the regulatory effect is not obvious. The immunoreactivity of SS in the small intestines of mice in the RTC groups was lower than that in the ETC groups after the same period of administration, which indirectly indicated that RTC had a stronger inhibitory effect on the secretion of SS than ETC. After 28 days of administration, the immunoreactivity of SS in the small intestine in each treatment group was reduced to different degrees compared with that in the control group. We speculated that TC and its processed products could significantly inhibit the secretion of SS in the small intestines of mice, and the high dose of RTC (4 g/kg) had the most significant effect. We speculated that after being processed by *Rubia cordifolia* L. and *Euphorbia fischeriana* Steud., the medicinal effect of TC was enhanced and that the secretion of SS cells was inhibited to different degrees. This may have been because *Rubia cordifolia* L. and *Euphorbia fischeriana* Steud changed the contents of some active components in TC, such as tannins and polyphenols, or because the processed products interacted with each other to form new components.

#### Effects of TC and its processed products on the distribution and function of SS in the small intestine

A large number of studies have shown that SS-IR cells not only regulate endocrine function but also regulate digestive function by external secretion (Ahlman H *et al.*, 1981; Huang X *et al.*, 2005). Some scholars have found that there are substances expressed in the processes of SS-IR cells that contact adjacent cells, suggesting that SS-IR cells have local paracrine regulatory function (Larsson L *et al.*, 1979). In this experiment, we found that the number of SS-IR cells in each intestinal segment in the administration group was decreased compared with that in the control group. Therefore, it was speculated that RTC and ETC have a certain inhibitory effect on the SS endocrine pathway. A few spindle-shaped SS cells were distributed in the lamina propria, and their processes pointed to the surrounding capillaries. In addition, some SS cells were cone-shaped or oval-shaped and distributed among intestinal epithelial cells, and their processes pointed toward the lamina propria. This provided a morphological basis for SS secretion and entry of SS into the blood circulation through the lamina propria. We also found cone-shaped or spindle-shaped SS cells, which were located between intestinal mucosal epithelial cells in many places in the small intestine, with processes that extended into the digestive cavity or acinar cavity. This provided possible morphological evidence for the exocrine function of SS. However, there was no significant difference in SS cell density between the control group and the administration group, indicating that drug administration had little effect on the SS exocrine pathway.

#### CONCLUSION

In this experiment, we studied the effect of TC and its processed products on the secretion and distribution of somatostatin in the small intestines of mice, which was first reported in China. The results showed that two processed products of TC had different inhibitory effects on the secretion and release of somatostatin in the small intestine and that the efficacies both of the processed products were enhanced compared to that of TC to different degrees. Therefore, processed products of TC

have great potential development and application prospects. Further analysis of the pharmacodynamic mechanism of processed products of TC is the main future research direction related to TC.

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#### CONFLICT OF INTEREST

The authors hereby declare that there are no conflicts of interest related to this article.

#### DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

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